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## **EXERGY ANALYSIS FOR ENERGY SYSTEMS**

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**Gorla Consultants, Inc.**

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**Final Report**

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## NOMENCLATURE

$a$	Tube radius or channel gap half-width
$Be$	Bejan Number
$Br$	Brinkman number
$C$	Fluid specific heat
$Dh$	Channel hydraulic diameter
$G_C$	G_axial
$G_F$	G_fluid friction
$G_H$	G_heat flux
$G_R$	G_radial
$k$	Thermal conductivity
$N_S$	Dimensionless entropy generation number
$N_F$	Entropy generation due to the fluid friction
$N_C$	Entropy generation due to heat transfer in the axial direction
$N_Y$	Entropy generation due to heat transfer in the transverse direction
$N_R$	Entropy generation due to heat transfer in the radial direction
$N_H$	Entropy generation due to heat transfer in the axial (or radial) and transverse direction
$Pe$	Peclet number
$q''_w$	Wall heat flux
$r$	Radial coordinate

$R$	Normalized radial coordinate, $r/a$
$s_e$	Volumetric Joule heating
$S$	Dimensionless joule heating parameter
$S_v$	Dimensionless viscous heating parameter
$T$	Absolute temperature
$T_m$	Mixed mean temperature
$T_w$	Channel wall temperature
$u$	Local fluid velocity
$u_{\max}$	Maximum possible electro-osmotic velocity
$\bar{u}$	Average velocity
$U$	Normalized local velocity, $u/\bar{u}$
$w$	Parallel plate channel width
$x$	Streamwise coordinate
$y$	Wall-normal coordinate
$Y$	Normalized wall-normal coordinate, $y/a$
$Z$	Relative duct radius, $a/\lambda$

### *Greek symbols*

$\alpha$	Thermal diffusivity
$\varepsilon$	Fluid dielectric constant
$\phi$	Applied potential field

$\Phi$	Irreversibility ratio
$\lambda$	Debye length
$\mu$	Fluid dynamic viscosity
$\theta$	Normalized temperature
$\theta_w$	Normalized wall temperature
$\rho$	Fluid density
$\psi$	Wall zeta potential

# **ENTROPY GENERATION IN THERMALLY FULLY DEVELOPED ELECTRO-OSMOTIC HEAT TRANSFER IN MICROCHANNELS**

## **ABSTRACT**

An analysis has been provided for the entropy generation in thermally fully developed electro-osmotically generated flow in a parallel plate microchannel and a circular microtube in terms of Brinkman number, Peclet number, relative duct radius, dimensionless joule heating parameter, dimensionless viscous heating parameter as well as physical properties of the fluid under imposed constant wall heat flux boundary condition. Such a flow is established not by an imposed pressure gradient, but by a voltage potential gradient along the length of the tube. The momentum and energy equations are solved to get the velocity and temperature distributions and the exact solution for the dimensionless entropy generation number have been determined analytically for both geometries. This analysis assumes no pressure-driven component to the velocity field and constant fluid properties. Five different variables namely, (i) dimensionless joule heating parameter, (ii) dimensionless viscous heating parameter, (iii) relative duct radius, (iv) Peclet number and (v) Brinkman number have been identified from the dimensionless entropy generation number equation. Various plots for dimensionless entropy generation number, Bejan number, Irreversibility ratio, entropy generation due to fluid friction etc. are generated using MATLAB and analyzed for both the configurations.

# CHAPTER I

## INTRODUCTION AND LITERATURE REVIEW

Microfluidic transport has found importance in a number of emerging technologies in micropower generation, chemical separation processes, cell analysis and other biomedical diagnostic techniques. At physical scales of order 100  $\mu\text{m}$ , generating fluid motion in the tube poses a considerable challenge. Conventional pressure-driven flow technology requires significant pressures, and while micropumps exist which are capable of delivering such pressures [1], they are difficult to manufacture and maintain, and lack the precise control that is often needed in microfluidic applications [2]. Electro-osmotic flow may provide a viable alternative to pressure-driven liquid flow at the microscale with better flow control and no moving parts. Several investigators have reported on electro-osmotic pump systems [3-4].

Electro-osmosis is the bulk movement of liquid relative to a stationary surface due to an externally applied electric field, and was first observed and reported by Reuss [5] nearly two centuries ago. Most solid substances will acquire a relative electric charge when in contact with an aqueous electrolytic solution, which in turn influences the charge distribution in the solution. Ions of opposite charge (counterions) to that of the surface are attracted towards the surface and ions of the same charge (coions) are repelled from the surface as shown in Fig 1a [6].

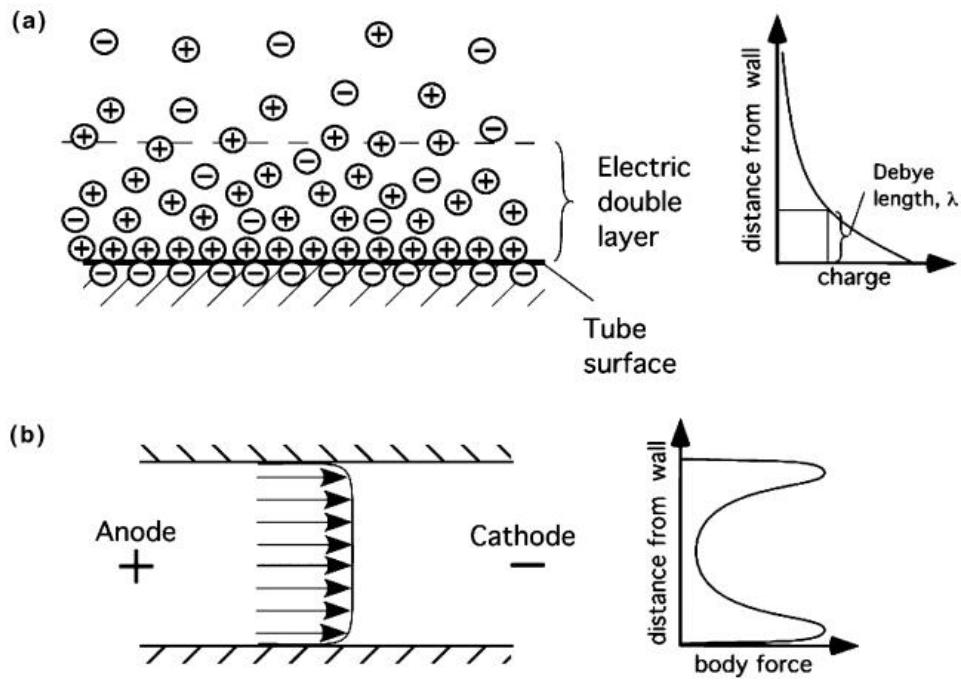


Figure 1a, b Schematic illustration of electro-osmotically generated flow

The net effect is the formation of a region close to the charged surface called the electric double layer [EDL] in which there is an excess of counter ions over coions, and which are distributed in a diffuse manner [7]. The charge distribution in the fluid therefore falls from its maximum near the wall to a zero charge in the fluid core. The thickness of the EDL is characterized by the Debye length, which is the wall-normal distance over which the net charge has decreased from the charge magnitude near the tube surface to  $1/e$  (37%) of the surface charge. The positively charged cations and solvent molecules strongly adsorbed at the wall remain stationary under the influence of an electric potential in the streamwise direction, while the mobile cations in the EDL very near the tube walls will migrate toward the cathode due to the excess charge in the layer. This gives rise to a concentrated fluid body force near the channel or tube walls as

illustrated in Fig 1b. Viscous shear forces transmitted from the EDL to the channel or tube center pull the core fluid towards the cathode as well. The resulting electro-osmotic flow velocity distribution is a function of the ratio of the hydraulic radius to the Debye length.

The fluid dynamics of electro-osmotically generated flow are significantly different from traditional pressure-driven flow, and therefore, the thermal transport dynamics are expected to be quite different as well. The applied driving voltage gradient and its induced electric conduction current establish Joule heating in the fluid, resulting in volumetric energy generation therein [6]. The magnitude of the thermal energy source has significant influence on the temperature distribution and heat transfer.

Several analytical studies have appeared in the literature describing the hydrodynamics of fully-developed electro-osmotic flow through circular tubes and rectangular channels. Specifically, several early papers report on electro-osmotic velocity distributions and the associated momentum transport in capillaries as a function of channel diameter-to-Debye length ratio [8, 9]. More recent hydrodynamic studies have explored the effects on the velocity field due to streamwise gradients in the electrical conductivity [10], the transient response of the velocity field to a suddenly applied voltage gradient [11] and the entry region flow field development [12]. Additionally, some experimental studies have reported on the velocity profile characteristics associated with fully-developed electro-osmotic flow in very long circular tubes and rectangular channels [13, 14].

With regard to characterization of the convection heat transfer associated with electro-osmotic flow, relatively little prior work has appeared in the literature. Li and

coworkers [15] have explored electrokinetic effects induced in a pressure-driven flow on the frictional and heat transfer characteristics for both round and rectangular microchannels. There also exists some early work exploring the effect of volumetric energy generation on thermal development in channels under pressure-driven flow conditions [16]. Knox [17] has explored the influence of Joule heating on efficiency in capillary electrophoresis. The fully-developed thermal transport for constant-property electro-osmotic flow in circular microtubes and parallel plate microchannels was previously explored for the case of negligible viscous heating [18]. Additionally, thermally fully-developed heat transfer has been explored for combined electro-osmotic and pressure driven, constant-property flow in a circular microtube under imposed constant wall heat flux boundary condition [19].

No studies have appeared in the literature that specifically address the entropy generation for purely electro-osmotically driven flow for both the configurations, parallel plate microchannel and circular microtube. The present work has been undertaken in order to study the entropy generation for fully-developed electro-osmotic flow in parallel plate microchannel and circular microtube for constant wall heat flux boundary condition. The results are then analyzed for both the configurations and conclusions are derived. This analysis assumes no pressure-driven component to the velocity field and constant fluid properties.

## CHAPTER II

### MATHEMATICAL FORMULATION AND ANALYSIS FOR PARALLEL PLATE MICROCHANNEL

Consider a fully developed electro-osmotically driven flow of an incompressible fluid in a parallel plate microchannel of infinite width with coordinates as defined in Figure 2a.

*Momentum transport:*

For steady flow without an applied pressure gradient the streamwise momentum equation reduces [18] to

$$\mu \frac{1}{y^n} \frac{d}{dy} \left( y^n \frac{du}{dy} \right) + \frac{\varepsilon}{y^n} \frac{d}{dy} \left( y^n \frac{d\psi}{dy} \right) \frac{d\phi}{dx} = 0 \quad (1)$$

Where,  $n = 0$ .  $\mu$  is the fluid viscosity,  $\varepsilon$  is the dielectric constant,  $\phi$  is the applied potential field and  $\psi(y)$  is the access charge distribution.

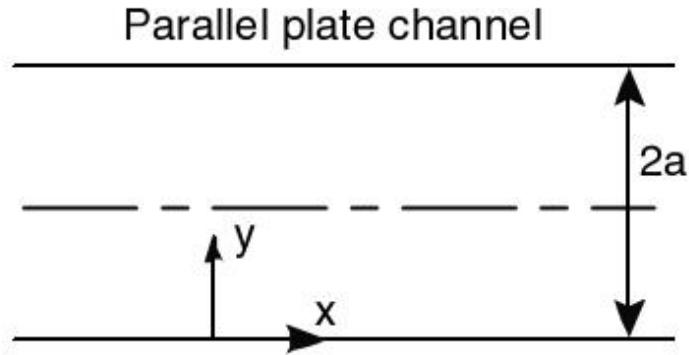


Figure 2a      Definition of coordinate system for Parallel plate microchannel

For low wall potential, the Debye–Hückel linearization is valid [7], and the excess charge distribution may be expressed explicitly as a function only of the zeta potential, the Debye length  $\lambda$  and the wall-normal coordinate  $y$ . For such a scenario, the momentum equation (1) may be solved subject to boundary conditions reflecting no slip at the wall and zero shear stress at the centerline, the fully-developed electro-osmotic velocity distribution for the parallel plate can be expressed as [2,7]

$$\frac{u}{u_{\max}} = 1 - Y \cdot Z \cdot e^{-Z} - e^{-Y \cdot Z} \quad (Y \leq 1) \quad (2)$$

where,  $Y = y/a$  is the normalized wall-normal coordinate and  $Z = a/\lambda$  is the relative duct radius. The Debye length  $\lambda$  is a function of the electro-chemical characteristics of the liquid / tube interface, and rather difficult to measure. It may be estimated from the relation  $\lambda = (\varepsilon RT / 2F^2 z^2 c)^{1/2}$  where  $\varepsilon$ ,  $T$ ,  $R$  and  $F$  are the fluid permittivity, absolute temperature, universal gas constant, and Faraday's constant respectively. The parameters  $z$  and  $c$  are the valence number and the average molar concentration of ions in the liquid solution.

Taking partial derivative of equation (2) with respect to  $Y$ ,

$$\frac{\partial \bar{u}}{\partial Y} = Z \cdot e^{-Y \cdot Z} - Z \cdot e^{-Z} \quad \text{where } \bar{u} = \frac{u}{u_{\max}}$$

We can also write  $\frac{\partial u}{\partial y}$  as,

$$\frac{\partial u}{\partial y} = \frac{\frac{\partial}{\partial y} \left( \frac{u}{u_{\max}} \right) \cdot u_{\max}}{\frac{\partial}{\partial y} \left( \frac{y}{a} \right) \cdot a}$$

$$\frac{\partial u}{\partial y} = \frac{u_{\max}}{a} \left( \frac{\partial \bar{u}}{\partial Y} \right)$$

$$\left( \frac{\partial u}{\partial y} \right)^2 = \frac{u_{\max}^2}{a^2} \left( Z^2 \cdot e^{-2 \cdot Y \cdot Z} - 2 \cdot Z^2 \cdot e^{-Z - Y \cdot Z} + Z^2 \cdot e^{-2 \cdot Z} \right) \quad (3)$$

*Energy equation:*

Given steady hydrodynamically fully developed flow with constant thermophysical properties, the energy equation simplifies [18] to

$$\frac{\partial^2 T}{\partial x^2} + \frac{1}{y^n} \frac{\partial}{\partial y} \left( y^n \frac{\partial T}{\partial y} \right) = \frac{u}{\alpha} \frac{\partial T}{\partial x} - \frac{s}{k} \quad (4)$$

where,  $n = 0$  for the channel flow.  $T$  is the local temperature,  $\alpha$  is the thermal diffusivity,  $k$  is the thermal conductivity and  $s$  is the volumetric Joule heating.

With an imposed constant heat flux boundary condition ( $q''_w = \text{constant}$ ),

$$\frac{\partial T}{\partial x} = \frac{dT_m}{dx} = \text{constant}$$

Furthermore, an energy balance on the fluid yields

$$\frac{\partial T}{\partial x} = \frac{4 \cdot q''_w}{\rho \cdot \bar{u} \cdot C \cdot D_h} + \frac{s}{\rho \cdot \bar{u} \cdot C} \quad (5)$$

In the above equation,  $Dh$  is the channel hydraulic diameter,  $q''_w$  is the wall heat flux and  $C$  is the fluid specific heat.

Performing square of equation (5),

$$\left(\frac{\partial T}{\partial x}\right)^2 = \left(\frac{16 \cdot q''_w^2 + s^2 \cdot D_h^2 + 8 \cdot q''_w \cdot s \cdot D_h}{\rho^2 \cdot \bar{u}^2 \cdot C^2 \cdot D_h^2}\right) \quad (6)$$

Now, the general expression for the temperature distribution for parallel plate microchannel [6] is,

$$\theta = \{1 + S \cdot [1 + S_v \cdot F(Z)]\} \cdot A_2(Y, Z) + S \cdot [A_1(Y) - S_v \cdot A_3 \cdot (Y, Z)] \quad (7)$$

where,  $S$  = dimensionless joule heating parameter,  $S_v$  = dimensionless viscous heating

parameter and  $\theta = \frac{k \cdot T}{a \cdot q''_w}$  = normalized temperature. Also,

$$F(Z) = \frac{3 \cdot e^{-2 \cdot Z}}{2 \cdot Z} - \frac{2 \cdot e^{-2 \cdot Z}}{Z} + e^{-2 \cdot Z} + \frac{1}{2 \cdot Z} \quad (8)$$

$$A_1(Y) = -\left(\frac{Y^2}{2} - Y\right) \quad (9)$$

$$A_2(Y, Z) = \frac{1}{Z^2} \left(1 - e^{-Y \cdot Z}\right) - Y \left(1 + \frac{e^{-Z}}{Z} - \frac{Z \cdot e^{-Z}}{2}\right) + \frac{Y^2}{2} - \frac{Y^3}{6} Z \cdot e^{-Z} \quad (10)$$

and

$$A_3(Y, Z) = \frac{1}{Z^2} \left[ \frac{1}{4} \left( e^{-2 \cdot Y \cdot Z} - 1 \right) + 2 \left( e^{-Z} - e^{-Z(Y+1)} \right) \right] - Y \left( e^{-2 \cdot Z} + \frac{3 \cdot e^{-2 \cdot Z}}{2 \cdot Z} \right) \quad (11)$$

Substituting the values of equations (8), (9), (10) and (11) into equation (7), we have

$$\begin{aligned}
\theta = & \left\{ 1 + S \cdot \left[ 1 + S_v \cdot \left( \frac{3 \cdot e^{-2Z}}{2 \cdot Z} - \frac{2 \cdot e^{-2Z}}{Z} + e^{-2Z} + \frac{1}{2 \cdot Z} \right) \right] \right\} \cdot \\
& \left( \frac{1}{Z^2} (1 - e^{-Y \cdot Z}) - Y \left( 1 + \frac{e^{-Z}}{Z} - \frac{Z \cdot e^{-Z}}{2} \right) + \frac{Y^2}{2} - \frac{Y^3}{6} Z \cdot e^{-Z} \right) + \\
& S \cdot \left[ \left( - \left( \frac{Y^2}{2} - Y \right) \right) - S_v \cdot \left( \frac{1}{Z^2} \left[ \frac{1}{4} (e^{-2Y \cdot Z} - 1) + 2(e^{-Z} - e^{-Z(Y+1)}) \right] - Y \left( e^{-2Z} + \frac{3 \cdot e^{-2Z}}{2 \cdot Z} \right) \right) \right]
\end{aligned} \tag{12}$$

Taking partial derivative of equation (12) with respect to  $Y$ ,

$$\frac{\partial \theta}{\partial Y} = Term1 \tag{13}$$

Where

$$\begin{aligned}
Term1 = & \left( \frac{e^{-Y \cdot Z}}{Z} - 1 - \frac{e^{-Z}}{Z} + \frac{Z \cdot e^{-Z}}{2} + Y - \frac{Z \cdot Y^2 \cdot e^{-Z}}{2} \right) + \\
& \left( \frac{S \cdot e^{-Y \cdot Z}}{Z} - S - \frac{S \cdot e^{-Z}}{Z} + \frac{S \cdot Z \cdot e^{-Z}}{2} + S \cdot Y - \frac{S \cdot Y^2 \cdot Z \cdot e^{-Z}}{2} \right) + \\
& \left( \frac{3 \cdot S \cdot S_v \cdot e^{-2Z-Y \cdot Z}}{2 \cdot Z^2} - \frac{3 \cdot S \cdot S_v \cdot e^{-2Z}}{2 \cdot Z} - \frac{3 \cdot S \cdot S_v \cdot e^{-3Z}}{2 \cdot Z^2} - \right. \\
& \left. \frac{3 \cdot S \cdot S_v \cdot e^{-3Z}}{4} + \frac{3 \cdot S \cdot S_v \cdot Y \cdot e^{-2Z}}{2 \cdot Z} - \frac{3 \cdot S \cdot S_v \cdot Y^2 \cdot e^{-3Z}}{4} \right) - \\
& \left( \frac{-2 \cdot S \cdot S_v \cdot e^{-Z-Y \cdot Z}}{Z^2} + \frac{2 \cdot S \cdot S_v \cdot e^{-Z}}{Z} + \frac{2 \cdot S \cdot S_v \cdot e^{-2Z}}{Z^2} - \right. \\
& \left. \frac{S \cdot S_v \cdot e^{-2Z}}{1} - \frac{2 \cdot S \cdot S_v \cdot Y \cdot e^{-Z}}{Z} + \frac{S \cdot S_v \cdot Y^2 \cdot e^{-2Z}}{1} \right) + \\
& \left( \frac{S \cdot S_v \cdot e^{-Z-Y \cdot Z}}{Z} - \frac{S \cdot S_v \cdot e^{-Z}}{1} - \frac{S \cdot S_v \cdot e^{-2Z}}{Z} + \frac{S \cdot S_v \cdot Z \cdot e^{-2Z}}{2} + \frac{S \cdot S_v \cdot Y \cdot e^{-Z}}{1} - \frac{S \cdot S_v \cdot Y^2 \cdot e^{-2Z}}{2} \right) + \\
& \left( \frac{S \cdot S_v \cdot e^{-Y \cdot Z}}{2 \cdot Z^2} - \frac{S \cdot S_v}{2 \cdot Z} - \frac{S \cdot S_v \cdot e^{-Z}}{2 \cdot Z^2} + \frac{S \cdot S_v \cdot Z \cdot e^{-Z}}{4 \cdot Z} + \frac{S \cdot S_v \cdot Y}{2 \cdot Z} - \frac{S \cdot S_v \cdot Y^2 \cdot e^{-Z}}{4} \right) + \\
& \left( S - S \cdot Y - \frac{S \cdot S_v \cdot e^{-2Y \cdot Z}}{2 \cdot Z} - \frac{2 \cdot S \cdot S_v \cdot e^{-Z-Y \cdot Z}}{Z} + \frac{S \cdot S_v \cdot e^{-2Z}}{1} - \frac{3 \cdot S \cdot S_v \cdot e^{-2Z}}{2 \cdot Z} \right)
\end{aligned}$$

Performing square of equation (13) using Mathematica,

$$\left( \frac{\partial \theta}{\partial Y} \right)^2 = [Term1]^2 \tag{14}$$

Also, we know,

$$\theta = \frac{k \cdot T}{a \cdot q_w''} \quad (15)$$

$$\left( \frac{\partial T}{\partial Y} \right)^2 = \left( \frac{a \cdot q_w''}{k} \right)^2 \cdot \left( \frac{\partial \theta}{\partial Y} \right)^2 \quad (16)$$

Substituting value of equation (14) into equation (16),

$$\left( \frac{\partial T}{\partial Y} \right)^2 = \left( \frac{a \cdot q_w''}{k} \right)^2 \cdot [Term1]^2 \quad (17)$$

We can also write  $\frac{\partial T}{\partial Y}$  as,

$$\frac{\partial T}{\partial Y} = \frac{\partial T}{\partial Y \cdot a \cdot 1/a}$$

$$\left( \frac{\partial T}{\partial Y} \right)^2 = a^2 \left( \frac{\partial T}{\partial y} \right)^2 \quad (18)$$

Comparing equations (17) and (18),

$$\left( \frac{\partial T}{\partial y} \right)^2 = \left( \frac{q_w''}{k} \right)^2 \cdot [Term1]^2 \quad (19)$$

Flow and heat transfer processes inside the plate are irreversible. The non-equilibrium conditions arise due to the exchange of energy, mass and momentum within the fluid and at solid boundaries, thus resulting in entropy generation. A part of the entropy production is due to the heat transfer in the direction of finite temperature and the other part of entropy production arises due to the fluid friction.

The equation for the entropy generation per unit volume is given by

$$S_G''' = \frac{\mu}{T_0} \left( \frac{\partial u}{\partial y} \right)^2 + \frac{k}{T_0^2} \left[ \left( \frac{\partial T}{\partial x} \right)^2 + \left( \frac{\partial T}{\partial y} \right)^2 \right] \quad (20)$$

In the above equation,

$$\frac{\mu}{T_0} \left( \frac{\partial u}{\partial y} \right)^2 = \text{friction Component} \quad \text{and}$$

$$\frac{k}{T_0^2} \left[ \left( \frac{\partial T}{\partial x} \right)^2 + \left( \frac{\partial T}{\partial y} \right)^2 \right] = \text{heat flux component}$$

here,  $\frac{k}{T_0^2} \left( \frac{\partial T}{\partial x} \right)^2$  = axial heat flux component and  $\frac{k}{T_0^2} \left( \frac{\partial T}{\partial y} \right)^2$  = transverse heat flux component

Multiplying both sides by  $k \cdot T_0^2 / q_w''^2$  to get the value of  $N_s$ ,

$$\left( \frac{k \cdot T_0^2}{q_w''^2} \right) S_G''' = N_s = \frac{\mu \cdot k \cdot T_0}{q_w''^2} \left( \frac{\partial u}{\partial y} \right)^2 + \frac{k^2}{q_w''^2} \left( \frac{\partial T}{\partial x} \right)^2 + \frac{k^2}{q_w''^2} \left( \frac{\partial T}{\partial y} \right)^2 \quad (21)$$

$$N_s = N_F + N_C + N_Y \quad (22)$$

In the above equations,

$N_s$  = dimensionless entropy generation number

$$N_F = \frac{\mu \cdot k \cdot T_0}{q_w''^2} \left( \frac{\partial u}{\partial y} \right)^2 = \text{entropy generation due to the fluid friction}$$

$$N_C = \frac{k^2}{q_w''^2} \left( \frac{\partial T}{\partial x} \right)^2 = \text{entropy generation due to heat transfer in the axial direction}$$

$$N_Y = \frac{k^2}{q_w''^2} \left( \frac{\partial T}{\partial y} \right)^2 = \text{entropy generation due to heat transfer in the transverse direction}$$

Substituting values from equations (3), (6) and (19) into equation (21),

$$\begin{aligned}
N_S = & \frac{\mu \cdot k \cdot T_0}{q_w''^2} \left[ \frac{u_{\max}^2}{a^2} (Z^2 \cdot e^{-2 \cdot Y \cdot Z} - 2 \cdot Z^2 \cdot e^{-Z-Y \cdot Z} + Z^2 \cdot e^{-2 \cdot Z}) \right] + \\
& \frac{k^2}{q_w''^2} \left[ \left( \frac{16 \cdot q_w''^2 + s^2 \cdot D_h^2 + 8 \cdot q_w'' \cdot s \cdot D_h}{\rho^2 \cdot \bar{u}^2 \cdot C^2 \cdot D_h^2} \right) \right] + \frac{k^2}{q_w''^2} \left[ \left( \frac{q_w''}{k} \right)^2 \cdot [Term1]^2 \right] \\
N_S = & \frac{u_{\max}^2 \cdot \mu \cdot k \cdot T_0}{q_w''^2 \cdot a^2} [Z^2 \cdot e^{-2 \cdot Y \cdot Z} - 2 \cdot Z^2 \cdot e^{-Z-Y \cdot Z} + Z^2 \cdot e^{-2 \cdot Z}] + \\
& \frac{k^2}{\rho^2 \cdot \bar{u}^2 \cdot C^2 \cdot D_h^2 \cdot q_w''^2} [16 \cdot q_w''^2 + s^2 \cdot D_h^2 + 8 \cdot q_w'' \cdot s \cdot D_h] + \\
& \left[ \left( \frac{e^{-Y \cdot Z}}{Z} - 1 - \frac{e^{-Z}}{Z} + \frac{Z \cdot e^{-Z}}{2} + Y - \frac{Z \cdot Y^2 \cdot e^{-Z}}{2} \right) + \right. \\
& \left( \frac{S \cdot e^{-Y \cdot Z}}{Z} - S - \frac{S \cdot e^{-Z}}{Z} + \frac{S \cdot Z \cdot e^{-Z}}{2} + S \cdot Y - \frac{S \cdot Y^2 \cdot Z \cdot e^{-Z}}{2} \right) + \\
& \left( \frac{3 \cdot S \cdot S_V \cdot e^{-2 \cdot Z-Y \cdot Z}}{2 \cdot Z^2} - \frac{3 \cdot S \cdot S_V \cdot e^{-2 \cdot Z}}{2 \cdot Z} - \frac{3 \cdot S \cdot S_V \cdot e^{-3 \cdot Z}}{2 \cdot Z^2} - \right. \\
& \left. \left( \frac{3 \cdot S \cdot S_V \cdot e^{-3 \cdot Z}}{4} + \frac{3 \cdot S \cdot S_V \cdot Y \cdot e^{-2 \cdot Z}}{2 \cdot Z} - \frac{3 \cdot S \cdot S_V \cdot Y^2 \cdot e^{-3 \cdot Z}}{4} \right) - \right. \\
& \left. \left( \frac{-2 \cdot S \cdot S_V \cdot e^{-Z-Y \cdot Z}}{Z^2} + \frac{2 \cdot S \cdot S_V \cdot e^{-Z}}{Z} + \frac{2 \cdot S \cdot S_V \cdot e^{-2 \cdot Z}}{Z^2} - \right. \right. \\
& \left. \left. \left( \frac{S \cdot S_V \cdot e^{-2 \cdot Z}}{1} - \frac{2 \cdot S \cdot S_V \cdot Y \cdot e^{-Z}}{Z} + \frac{S \cdot S_V \cdot Y^2 \cdot e^{-2 \cdot Z}}{1} \right) + \right. \right. \\
& \left. \left( \frac{S \cdot S_V \cdot e^{-Z-Y \cdot Z}}{Z} - \frac{S \cdot S_V \cdot e^{-Z}}{1} - \frac{S \cdot S_V \cdot e^{-2 \cdot Z}}{Z} + \right. \right. \\
& \left. \left. \left( \frac{S \cdot S_V \cdot Z \cdot e^{-2 \cdot Z}}{2} + \frac{S \cdot S_V \cdot Y \cdot e^{-Z}}{1} - \frac{S \cdot S_V \cdot Y^2 \cdot e^{-2 \cdot Z}}{2} \right) + \right. \right. \\
& \left. \left( \frac{S \cdot S_V \cdot e^{-Y \cdot Z}}{2 \cdot Z^2} - \frac{S \cdot S_V}{2 \cdot Z} - \frac{S \cdot S_V \cdot e^{-Z}}{2 \cdot Z^2} + \frac{S \cdot S_V \cdot Z \cdot e^{-Z}}{4 \cdot Z} + \frac{S \cdot S_V \cdot Y}{2 \cdot Z} - \frac{S \cdot S_V \cdot Y^2 \cdot e^{-Z}}{4} \right) + \right. \right. \\
& \left. \left( S - S \cdot Y - \frac{S \cdot S_V \cdot e^{-2 \cdot Y \cdot Z}}{2 \cdot Z} - \frac{2 \cdot S \cdot S_V \cdot e^{-Z-Y \cdot Z}}{Z} + \frac{S \cdot S_V \cdot e^{-2 \cdot Z}}{1} - \frac{3 \cdot S \cdot S_V \cdot e^{-2 \cdot Z}}{2 \cdot Z} \right) \right] ^2
\end{aligned} \tag{23}$$

Brinkman number (Br) and Peclet number (Pe) are defined as,

$$Br = \frac{u_{\max}^2 \cdot \mu \cdot k \cdot T_0}{q_w''^2 \cdot a^2} \quad \text{and}$$

$$Pe = \frac{\rho \cdot \bar{u} \cdot C \cdot D_h \cdot q_w''}{k} \quad (24)$$

Substituting values of Brinkman number (Br) and Peclet number (Pe) from equation (24) into equation (23),

$$N_S = Br \cdot [Z^2 \cdot e^{-2 \cdot Y \cdot Z} - 2 \cdot Z^2 \cdot e^{-Z-Y \cdot Z} + Z^2 \cdot e^{-2 \cdot Z}] + \frac{1}{Pe^2} \cdot [16 \cdot q_w''^2 + s^2 \cdot D_h^2 + 8 \cdot q_w'' \cdot s \cdot D_h] + [Term1]^2 \quad (25)$$

Here,

$$N_F = Br \cdot [Z^2 \cdot e^{-2 \cdot Y \cdot Z} - 2 \cdot Z^2 \cdot e^{-Z-Y \cdot Z} + Z^2 \cdot e^{-2 \cdot Z}]$$

$$N_C = \frac{1}{Pe^2} \cdot [16 \cdot q_w''^2 + s^2 \cdot D_h^2 + 8 \cdot q_w'' \cdot s \cdot D_h] \quad \text{and}$$

$$N_Y = \left[ \begin{aligned} & \left( \frac{e^{-Y \cdot Z}}{Z} - 1 - \frac{e^{-Z}}{Z} + \frac{Z \cdot e^{-Z}}{2} + Y - \frac{Z \cdot Y^2 \cdot e^{-Z}}{2} \right) + \\ & \left( \frac{S \cdot e^{-Y \cdot Z}}{Z} - S - \frac{S \cdot e^{-Z}}{Z} + \frac{S \cdot Z \cdot e^{-Z}}{2} + S \cdot Y - \frac{S \cdot Y^2 \cdot Z \cdot e^{-Z}}{2} \right) + \\ & \left( \frac{3 \cdot S \cdot S_V \cdot e^{-2 \cdot Z - Y \cdot Z}}{2 \cdot Z^2} - \frac{3 \cdot S \cdot S_V \cdot e^{-2 \cdot Z}}{2 \cdot Z} - \frac{3 \cdot S \cdot S_V \cdot e^{-3 \cdot Z}}{2 \cdot Z^2} - \right. \\ & \left. \frac{3 \cdot S \cdot S_V \cdot e^{-3 \cdot Z}}{4} + \frac{3 \cdot S \cdot S_V \cdot Y \cdot e^{-2 \cdot Z}}{2 \cdot Z} - \frac{3 \cdot S \cdot S_V \cdot Y^2 \cdot e^{-3 \cdot Z}}{4} \right) - \\ & \left( \frac{-2 \cdot S \cdot S_V \cdot e^{-Z - Y \cdot Z}}{Z^2} + \frac{2 \cdot S \cdot S_V \cdot e^{-Z}}{Z} + \frac{2 \cdot S \cdot S_V \cdot e^{-2 \cdot Z}}{Z^2} - \right. \\ & \left. \frac{S \cdot S_V \cdot e^{-2 \cdot Z}}{1} - \frac{2 \cdot S \cdot S_V \cdot Y \cdot e^{-Z}}{Z} + \frac{S \cdot S_V \cdot Y^2 \cdot e^{-2 \cdot Z}}{1} \right) + \\ & \left( \frac{S \cdot S_V \cdot e^{-Z - Y \cdot Z}}{Z} - \frac{S \cdot S_V \cdot e^{-Z}}{1} - \frac{S \cdot S_V \cdot e^{-2 \cdot Z}}{Z} + \right. \\ & \left. \frac{S \cdot S_V \cdot Z \cdot e^{-2 \cdot Z}}{2} + \frac{S \cdot S_V \cdot Y \cdot e^{-Z}}{1} - \frac{S \cdot S_V \cdot Y^2 \cdot e^{-2 \cdot Z}}{2} \right) + \\ & \left( \frac{S \cdot S_V \cdot e^{-Y \cdot Z}}{2 \cdot Z^2} - \frac{S \cdot S_V}{2 \cdot Z} - \frac{S \cdot S_V \cdot e^{-Z}}{2 \cdot Z^2} + \frac{S \cdot S_V \cdot Z \cdot e^{-Z}}{4 \cdot Z} + \frac{S \cdot S_V \cdot Y}{2 \cdot Z} - \frac{S \cdot S_V \cdot Y^2 \cdot e^{-Z}}{4} \right) + \\ & \left( S - S \cdot Y - \frac{S \cdot S_V \cdot e^{-2 \cdot Y \cdot Z}}{2 \cdot Z} - \frac{2 \cdot S \cdot S_V \cdot e^{-Z - Y \cdot Z}}{Z} + \frac{S \cdot S_V \cdot e^{-2 \cdot Z}}{1} - \frac{3 \cdot S \cdot S_V \cdot e^{-2 \cdot Z}}{2 \cdot Z} \right) \end{aligned} \right]^2$$

### **Irreversibility Ratio ( $\Phi$ ): -**

In our case, both the fluid friction and the heat transfer contribute to the rate of entropy generation. In order to assess which one among the fluid friction and heat transfer dominates, a criterion known as irreversibility ratio is defined by the following equation. Irreversibility ratio ( $\Phi$ ) is the ratio of entropy generation due to the fluid friction to the total entropy generation due to heat transfer.

$$\Phi = \frac{\text{Fluid Friction Component}}{\text{Axial Heat Flux Component} + \text{Transverse Heat Flux Component}}$$

$$\Phi = \frac{N_F}{N_C + N_Y} \quad (26)$$

For  $0 \leq \Phi < 1$ , the heat transfer dominates the irreversibility ratio and the fluid friction dominates when  $\Phi > 1$ . The case where both the heat transfer and the fluid friction have the same contribution for the entropy generation is characterized by  $\Phi = 1$ .

### **Bejan number (Be): -**

Bejan number is the ratio of heat transfer irreversibility to the total irreversibility due to fluid friction and heat transfer.

$$Be = \frac{\text{Heat Flux Components}}{\text{Fluid Friction Component} + \text{Heat Flux Components}}$$

$$Be = \frac{N_C + N_Y}{N_F + N_C + N_Y}$$

$$Be = \frac{1}{1 + \Phi} \quad (27)$$

Bejan number ranges from 0 to 1.  $Be = 0$  is the limit where the irreversibility is dominated by fluid frictional effects and  $Be = 1$  corresponds to the limit where the irreversibility due to heat transfer by virtue of finite temperature differences dominates.

Similarly, we define the following dimensionless ratios:

$$G_{Friction} = \frac{Fluid\ Friction\ Component}{Fluid\ Friction\ Component + Heat\ Flux\ Components}$$

$$G_F = \frac{N_F}{N_F + N_C + N_Y} \quad (28)$$

and

$$G_{Heat\ Flux} = \frac{Heat\ Flux\ Components}{Fluid\ Friction\ Component + Heat\ Flux\ Components}$$

$$G_H = \frac{N_C + N_Y}{N_F + N_C + N_Y} \quad (29)$$

## CHAPTER III

### MATHEMATICAL FORMULATION AND ANALYSIS FOR CIRCULAR MICROTUBE

Consider a fully developed electro-osmotically driven flow of an incompressible fluid in a circular microtube with coordinates defined in Figure 2b.

*Momentum transport:*

For a steady flow without an applied pressure gradient the streamwise momentum equation reduces [18] to

$$\mu \frac{1}{r^n} \frac{d}{dr} \left( r^n \frac{du}{dr} \right) + \frac{\varepsilon}{r^n} \frac{d}{dr} \left( r^n \frac{d\psi}{dr} \right) \frac{d\phi}{dx} = 0 \quad (30)$$

where,  $n = 1$  for circular microtube.  $\mu$  is the fluid viscosity,  $\varepsilon$  is the dielectric constant,  $\phi$  is the applied potential field and  $\psi(r)$  is the access charge distribution.

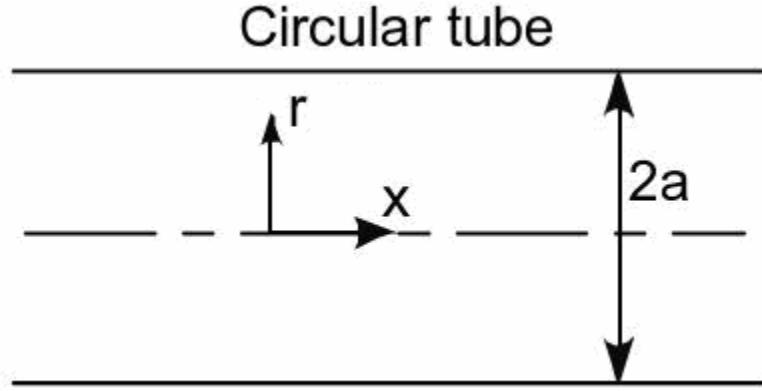


Figure 2b      Definition of coordinate system Circular microtube

For low wall potential, the Debye–Hückel linearization is valid [7], and the excess charge distribution may be expressed explicitly as a function only of the zeta potential, the Debye length  $\lambda$  and the radial coordinate  $r$ . For such a scenario, the momentum equation may be solved subject to boundary conditions reflecting no slip at the wall and zero shear stress at the centerline, yielding fully-developed electro-osmotic velocity distribution for the circular microtube, as [2,7]

$$\frac{u}{u_{eo}} = 1 - \frac{I_0(Z \cdot R)}{I_0(Z)} \quad (31)$$

where,  $R = r/a$  is the normalized radial coordinate,  $Z = a/\lambda$  is the Relative duct radius,  $I_0$  is the modified Bessel function of the first kind of order 0 and its general expression [20] is given by,

$$I_0(x) = 1 + \frac{x^2}{2^2(1!)^2} + \frac{x^4}{2^4(2!)^4} + \frac{x^6}{2^6(3!)^6} + \dots, \quad (32)$$

For our case, considering first few terms for simplification, equation (32) becomes,

$$I_0(Z \cdot R) = 1 + \frac{Z^2 \cdot R^2}{4} + \frac{Z^4 \cdot R^4}{64} \quad (33)$$

The Debye length  $\lambda$  is a function of the electro-chemical characteristics of the liquid / tube interface, and rather difficult to measure. It may be estimated from the relation

$\lambda = (\varepsilon RT / 2F^2 z^2 c)^{1/2}$  where  $\varepsilon$ ,  $T$ ,  $R$  and  $F$  are the fluid permittivity, absolute temperature, universal gas constant, and Faraday's constant respectively. The parameters  $z$  and  $c$  are the valence number and the average molar concentration of ions in the liquid solution.

Substituting value from equation (33) into equation (31),

$$\frac{u}{u_{\max}} = \frac{16 \cdot Z^2 + Z^4 - 16 \cdot Z^2 \cdot R^2 - Z^4 \cdot R^4}{Z^4 + 16 \cdot Z^2 + 64}$$

Taking partial derivative of the above equation with respect to  $R$ ,

$$\frac{\partial \bar{u}}{\partial R} = \frac{-32 \cdot Z^2 \cdot R - 4 \cdot Z^4 \cdot R^3}{Z^4 + 16 \cdot Z^2 + 64} \quad \text{where, } \bar{u} = \frac{u}{u_{\max}}$$

We can also write  $\frac{\partial u}{\partial r}$  as,

$$\begin{aligned} \frac{\partial u}{\partial r} &= \frac{\partial \frac{u}{u_{\max}} \cdot u_{\max}}{\partial \frac{r}{a} \cdot a} \\ \frac{\partial u}{\partial r} &= \frac{u_{\max}}{a} \left( \frac{\partial \bar{u}}{\partial R} \right) \\ \left( \frac{\partial u}{\partial r} \right)^2 &= \frac{u_{\max}^2}{a^2} \left( \frac{1024 \cdot R^2 \cdot Z^4 + 256 \cdot R^4 \cdot Z^6 + 16 \cdot R^6 \cdot Z^8}{4096 + 2048 \cdot Z^2 + 384 \cdot Z^4 + 32 \cdot Z^6 + Z^8} \right) \end{aligned} \quad (34)$$

*Energy equation:*

Given steady hydrodynamically fully developed flow with constant thermophysical properties, the energy equation simplifies [3] to

$$\frac{\partial^2 T}{\partial x^2} + \frac{1}{r^n} \frac{\partial}{\partial r} \left( r^n \frac{\partial T}{\partial r} \right) = \frac{u}{\alpha} \frac{\partial T}{\partial x} - \frac{s}{k}$$

where,  $n = 1$  for the circular microtube.  $T$  is the local temperature,  $\alpha$  is the thermal diffusivity,  $k$  is the thermal conductivity and  $s$  is the volumetric Joule heating.

With an imposed constant heat flux boundary condition ( $q''_w = \text{constant}$ ),

$$\frac{\partial T}{\partial x} = \frac{dT_m}{dx} = \text{Constant}$$

Furthermore, an energy balance on the fluid yields

$$\frac{\partial T}{\partial x} = \frac{4 \cdot q''_w}{\rho \cdot \bar{u} \cdot C \cdot D_h} + \frac{s}{\rho \cdot \bar{u} \cdot C} \quad (35)$$

In the above equation,  $D_h$  is the channel hydraulic diameter,  $q''_w$  is the wall heat flux and  $C$  is the fluid specific heat.

Performing square of equation (35),

$$\left( \frac{\partial T}{\partial x} \right)^2 = \left( \frac{16 \cdot q''_w^2 + s^2 \cdot D_h^2 + 8 \cdot q''_w \cdot s \cdot D_h}{\rho^2 \cdot \bar{u}^2 \cdot C^2 \cdot D_h^2} \right) \quad (36)$$

Now, the general expression for the temperature distribution for circular microtube [6] is,

$$\theta = \{2 + S \cdot [1 + S_v \cdot F(Z)]\} \cdot A_2(R, Z) + S \cdot [A_1(R) - S_v \cdot A_3(R, Z)] \quad (37)$$

where,  $S$  = dimensionless joule heating parameter,  $S_v$  = dimensionless viscous heating

parameter and  $\theta = \frac{k \cdot T}{\alpha \cdot q''_w}$  = normalized temperature. Also,

$$F(Z) = \frac{I_1^2(Z)}{I_0^2(Z)} + \frac{2}{Z} \frac{I_1(Z)}{I_0(Z)} - 1 \quad (38)$$

$$A_1(R) = -\frac{1}{4} (R^2 - 1) \quad (39)$$

$$A_2(R, Z) = \frac{1}{Z^2} \left[ 1 - \frac{I_0(R \cdot Z)}{I_0(Z)} \right] + \frac{1}{4} (R^2 - 1) \quad (40)$$

and

$$\begin{aligned} A_3(R, Z) = & \frac{1}{2} \left[ 1 - \frac{I_1^2(Z)}{I_0^2(Z)} \right] + \frac{1}{2 \cdot Z} \left[ R \cdot \frac{I_1(R \cdot Z) \cdot I_0(R \cdot Z)}{I_0^2(Z)} - \frac{I_1(Z)}{I_0(Z)} \right] + \\ & \frac{1}{2 \cdot Z^2} \left[ \frac{I_0^2(R \cdot Z)}{I_0^2(Z)} - 1 \right] - \frac{R^2}{2} \left[ \frac{I_0^2(R \cdot Z)}{I_0^2(Z)} - \frac{I_1^2(R \cdot Z)}{I_0^2(Z)} \right] \end{aligned} \quad (41)$$

In the above equations,  $I_1$  is the modified Bessel function of the first kind of order 1 and its general expression [5] is given by,

$$I_1(x) = \frac{x}{2} + \frac{x^3}{2^3 \cdot 1! \cdot 2!} + \frac{x^5}{2^5 \cdot 2! \cdot 3!} + \frac{x^7}{2^7 \cdot 3! \cdot 4!} + \dots, \quad (42)$$

For our case, considering first few terms for simplification, equation (42) becomes,

$$I_1(R \cdot Z) = \frac{R \cdot Z}{2} + \frac{(R \cdot Z)^3}{16} + \frac{(R \cdot Z)^5}{384} \quad (43)$$

Substituting the values of equations (38), (39), (40), (41) and (43) into equation (37),

$$\begin{aligned} \theta = & \left\{ 2 + S \cdot \left[ 1 + S_v \cdot \left( \frac{I_1^2(Z)}{I_0^2(Z)} + \frac{2}{Z} \frac{I_1(Z)}{I_0(Z)} - 1 \right) \right] \right\} \cdot \left( \frac{1}{Z^2} \left[ 1 - \frac{I_0(R \cdot Z)}{I_0(Z)} \right] + \frac{1}{4} (R^2 - 1) \right) + \\ & S \cdot \left( -\frac{1}{4} (R^2 - 1) \right) - S_v \cdot \left( \frac{1}{2} \left[ 1 - \frac{I_1^2(Z)}{I_0^2(Z)} \right] + \frac{1}{2 \cdot Z} \left[ R \cdot \frac{I_1(R \cdot Z) \cdot I_0(R \cdot Z)}{I_0^2(Z)} - \frac{I_1(Z)}{I_0(Z)} \right] + \right. \\ & \left. \frac{1}{2 \cdot Z^2} \left[ \frac{I_0^2(R \cdot Z)}{I_0^2(Z)} - 1 \right] - \frac{R^2}{2} \left[ \frac{I_0^2(R \cdot Z)}{I_0^2(Z)} - \frac{I_1^2(R \cdot Z)}{I_0^2(Z)} \right] \right) \end{aligned} \quad (44)$$

Taking partial derivative of equation (44) with respect to  $R$  and talking square using Mathematica,

$$\left(\frac{\partial \theta}{\partial R}\right)^2 = [Term\ 2]^2 \quad (45)$$

Also, we know,

$$\theta = \frac{k \cdot T}{a \cdot q_w''} \quad (46)$$

$$\left(\frac{\partial T}{\partial R}\right)^2 = \left(\frac{a \cdot q_w''}{k}\right)^2 \cdot \left(\frac{\partial \theta}{\partial R}\right)^2 \quad (47)$$

Substituting value of equation (45) into equation (47),

$$\left(\frac{\partial T}{\partial R}\right)^2 = \left(\frac{a \cdot q_w''}{k}\right)^2 \cdot [Term\ 2]^2 \quad (48)$$

We can also write  $\partial T / \partial R$  as,

$$\begin{aligned} \left(\frac{\partial T}{\partial R}\right) &= \left(\frac{\partial T}{\partial R \cdot a \cdot 1/a}\right) \\ \left(\frac{\partial T}{\partial R}\right)^2 &= a^2 \left(\frac{\partial T}{\partial r}\right)^2 \end{aligned} \quad (49)$$

Comparing equations (48) and (49),

$$\left(\frac{\partial T}{\partial r}\right)^2 = \left(\frac{q_w''}{k}\right)^2 \cdot [Term\ 2]^2 \quad (50)$$

Flow and heat transfer processes inside the tube are irreversible. The non-equilibrium conditions arise due to the exchange of energy, mass and momentum within the fluid and at solid boundaries, thus resulting in entropy generation. A part of the entropy production is due to the heat transfer in the direction of finite temperature and the other part of entropy production arises due to the fluid friction.

The equation for the entropy generation per unit volume for a circular microtube is given by

$$S_G''' = \frac{\mu}{T_0} \left( \frac{\partial u}{\partial r} \right)^2 + \frac{k}{T_0^2} \left[ \left( \frac{\partial T}{\partial x} \right)^2 + \left( \frac{\partial T}{\partial r} \right)^2 \right] \quad (51)$$

In the above equation,

$$\frac{\mu}{T_0} \left( \frac{\partial u}{\partial r} \right)^2 = \text{friction component}$$

$$\frac{k}{T_0^2} \left[ \left( \frac{\partial T}{\partial x} \right)^2 + \left( \frac{\partial T}{\partial r} \right)^2 \right] = \text{heat flux component}$$

here,  $\frac{k}{T_0^2} \left( \frac{\partial T}{\partial x} \right)^2$  = axial heat flux component and  $\frac{k}{T_0^2} \left( \frac{\partial T}{\partial r} \right)^2$  = radial heat flux

component

Multiplying both sides by  $k \cdot T_0^2 / q_w''^2$  to get the value of  $N_S$ ,

$$\left( \frac{k \cdot T_0^2}{q_w''^2} \right) S_G''' = N_S = \frac{\mu \cdot k \cdot T_0}{q_w''^2} \left( \frac{\partial u}{\partial r} \right)^2 + \frac{k^2}{q_w''^2} \left( \frac{\partial T}{\partial x} \right)^2 + \frac{k^2}{q_w''^2} \left( \frac{\partial T}{\partial r} \right)^2 \quad (52)$$

$$N_S = N_F + N_C + N_R \quad (53)$$

In the above equations,

$N_S$  = Dimensionless entropy generation number

$$N_F = \frac{\mu \cdot k \cdot T_0}{q_w''^2} \left( \frac{\partial u}{\partial r} \right)^2 = \text{entropy generation due to the fluid friction}$$

$$N_C = \frac{k^2}{q_w''^2} \left( \frac{\partial T}{\partial x} \right)^2 = \text{entropy generation due to heat transfer in the axial direction}$$

$$N_R = \frac{k^2}{q_w''^2} \left( \frac{\partial T}{\partial r} \right)^2 = \text{entropy generation due to heat transfer in the radial direction}$$

Substituting values from equations (34), (36) and (50) into equation (52),

$$N_S = \frac{u^2_{\max} \cdot \mu \cdot k \cdot T_0}{q_w''^2 \cdot a^2} \left[ \frac{1024 \cdot R^2 \cdot Z^4 + 256 \cdot R^4 \cdot Z^6 + 16 \cdot R^6 \cdot Z^8}{4096 + 2048 \cdot Z^2 + 384 \cdot Z^4 + 32 \cdot Z^6 + Z^8} \right] + \frac{k^2}{\rho^2 \cdot \bar{u}^2 \cdot C^2 \cdot D_h^2 \cdot q_w''^2} \left[ 16 \cdot q_w''^2 + s^2 \cdot D_h^2 + 8 \cdot q_w'' \cdot s \cdot D_h \right] + [Term \ 2]^2 \quad (54)$$

Taking values of Brinkman number (Br) and Peclet number (Pe) from equation (24) and substituting into equation (54),

$$N_S = Br \cdot \left[ \frac{1024 \cdot R^2 \cdot Z^4 + 256 \cdot R^4 \cdot Z^6 + 16 \cdot R^6 \cdot Z^8}{4096 + 2048 \cdot Z^2 + 384 \cdot Z^4 + 32 \cdot Z^6 + Z^8} \right] + \frac{1}{Pe^2} \left[ 16 \cdot q_w''^2 + s^2 \cdot D_h^2 + 8 \cdot q_w'' \cdot s \cdot D_h \right] + (Term \ 2)^2 \quad (55)$$

here,

$$N_F = Br \cdot \left[ \frac{1024 \cdot R^2 \cdot Z^4 + 256 \cdot R^4 \cdot Z^6 + 16 \cdot R^6 \cdot Z^8}{4096 + 2048 \cdot Z^2 + 384 \cdot Z^4 + 32 \cdot Z^6 + Z^8} \right]$$

$$N_C = \frac{1}{Pe^2} \cdot \left[ 16 \cdot q_w''^2 + s^2 \cdot D_h^2 + 8 \cdot q_w'' \cdot s \cdot D_h \right]$$

and

$$N_R = Term \ 2$$

### Irreversibility Ratio ( $\Phi$ ): -

In the case of circular microtube,

$$\Phi = \frac{Fluid \ Friction \ Component}{Axial \ Heat \ Flux \ Component + Radial \ Heat \ Flux \ Component}$$

$$\Phi = \frac{N_F}{N_C + N_R} \quad (56)$$

**Bejan number (Be): -**

In the case of circular microtube,

$$Be = \frac{\text{Heat Flux Components}}{\text{Fluid Friction Component} + \text{Heat Flux Components}}$$

$$Be = \frac{N_C + N_R}{N_F + N_C + N_R}$$

$$Be = \frac{1}{1 + \Phi} \quad (57)$$

Similarly, we can define the following dimensionless ratios:

$$G_{\text{Friction}} = \frac{\text{Fluid Friction Component}}{\text{Fluid Friction Component} + \text{Heat Flux Components}}$$

$$G_F = \frac{N_F}{N_F + N_C + N_R} \quad (58)$$

$$G_{\text{Axial}} = \frac{\text{Axial Heat Flux Components}}{\text{Fluid Friction Component} + \text{Heat Flux Components}}$$

$$G_C = \frac{N_C}{N_F + N_C + N_R} \quad (59)$$

and

$$G_{\text{Radial}} = \frac{\text{Radial Heat Flux Components}}{\text{Fluid Friction Component} + \text{Heat Flux Components}}$$

$$G_R = \frac{N_R}{N_F + N_C + N_R} \quad (60)$$

## CHAPTER IV

### DISCUSSION OF RESULTS

We have presented an analysis for the entropy generation on thermally fully developed, electro-osmotically generated flow for a parallel plate microchannel and a circular microtube under constant wall heat flux boundary condition. The fluid is assumed to be water. The velocity and the temperature distributions are obtained analytically from the momentum equation and energy equation and used to compute the entropy generation, dimensionless entropy generation number ( $N_s$ ), Irreversibility ratio ( $\Phi$ ), Bejan number ( $Be$ ) and the dimensionless ratios: G\_fluid friction ( $G_F$ ) and G\_heat flux ( $G_H$ ). These parameters are presented graphically for various values of dimensionless joule heating parameter ( $S$ ), dimensionless viscous heating parameter ( $S_v$ ), relative duct radius ( $Z$ ), Brinkman number ( $Br$ ) and Peclet number ( $Pe$ ).

#### Parallel plate microchannel:

Figure 3 shows the distribution of dimensionless entropy generation number  $N_s$  for constant values of  $S$ ,  $S_v$ ,  $Z$  and  $Pe$ . Here, Brinkman number  $Br$  is chosen as a

parameter ranging from 0.2 to 1.0. From the figure, it is clear that  $N_s$  decreases as  $Y$  increases. Also as the value of  $Br$  increases,  $N_s$  also increases for a given value of  $Y$ . Figure 4 displays the Bejan number  $Be$  versus  $Y$ .  $Be$  is the ratio of heat transfer irreversibility to the total irreversibility due to fluid friction and heat transfer. Bejan number increases as the value of  $Y$  increases and approaches 1. Also as the value of  $Br$  increases,  $Be$  decreases. In Figure 5, Irreversibility ratio  $\Phi$  is plotted versus  $Y$ . Irreversibility ratio  $\Phi$  is the ratio of entropy generation due to the fluid friction to the total entropy generation due to heat transfer. Irreversibility ratio decreases as the value of  $Y$  increases and approaches 0. For  $0 \leq \Phi < 1$ , the heat transfer dominates the irreversibility ratio and the fluid friction dominates when  $\Phi > 1$ . Also it can be noted that as the value of  $Br$  increases,  $\Phi$  increases. Figures 6 and 7 show the dimensionless ratios  $G_f$  and  $G_h$  versus  $Y$ . Looking at the equations and plots, the plots for  $G_f$  are similar to  $\Phi$  and the plots for  $G_h$  are similar to  $Be$ . Figure 8 shows the entropy generation due to fluid friction  $N_f$  versus  $Y$ . It can be seen that as the value of  $Br$  increases,  $N_f$  increases for a particular value of  $Y$ . In Figure 9,  $N_h$  is plotted versus  $N_f$ . It can be seen that for a particular value of  $N_f$ , the value of  $N_h$  increases as  $Br$  increases.

In Figure 10,  $N_s$  is plotted versus  $Y$  for constant values of  $S$ ,  $Sv$ ,  $Br$  and  $Pe$ . Here relative duct radius  $Z$  is chosen as a parameter ranging from 6.5 to 15. It can be seen that as  $Z$  increases,  $N_s$  also increases. From Figures 11 and 12, it is clear that as the value of  $Z$  increases,  $Be$  decreases and  $\Phi$  increases for any value of  $Y$ . Figures 15 and 16 show  $N_f$  and  $N_h$  versus  $Y$  respectively. It can be seen here that as  $Z$  increases, value of  $N_f$  and  $N_h$  also increases. In Figure 18,  $N_s$  is plotted versus  $Y$  for constant values of  $S$ ,  $Sv$ ,  $Br$  and  $Z$ . Here Peclet number  $Pe$  is chosen as a parameter ranging from 2 to 10. It can be seen that

as the value of  $Pe$  increases,  $Ns$  decreases. From Figures 19 and 20, it is clear that as the value of  $Pe$  increases,  $Be$  decreases and  $\Phi$  increases for any value of  $Y$ . Figures 23 and 24 show  $N_c$  and  $N_h$  versus  $Y$  respectively. It can be seen here that as  $Pe$  increases, value of  $N_c$  and  $N_h$  decreases. From Figure 25 it can be seen that, for any given value of  $N_h$ ,  $N_f$  decreases with the increase in the value of  $Pe$ .

In Figure 26,  $Ns$  is plotted versus  $Y$  for constant values of  $Pe$ ,  $Sv$ ,  $Br$  and  $Z$ . Here dimensionless joule heating parameter  $S$  is chosen as a parameter ranging from 1 to 5. It can be seen that as the value of  $S$  increases,  $Ns$  also increases. From Figures 27 and 28, it is clear that as the value of  $S$  increases,  $Be$  increases and  $\Phi$  decreases for any value of  $Y$ . In Figure 31,  $N_h$  is plotted versus  $Y$ . It can be seen here that as  $S$  increases, value of  $N_h$  also increases. From Figure 32, it can be seen that for any given value of  $N_h$ , as  $S$  increases,  $N_f$  also increases. In Figure 33,  $Ns$  is plotted versus  $Y$  for constant values of  $Pe$ ,  $S$ ,  $Br$  and  $Z$ . Here dimensionless viscous heating parameter  $Sv$  is chosen as a parameter ranging from 1 to 5. It can be seen that as the value of  $Sv$  increases,  $Ns$  decreases. From Figures 34 and 35, it is clear that as the value of  $Sv$  increases,  $Be$  decreases and  $\Phi$  increases for any value of  $Y$ . In Figure 38,  $N_f$  is plotted versus  $Y$ . It can be seen here that as  $Y$  increases, value of  $N_f$  decreases and it is independent of  $Sv$ . We can see from Figure 39 that  $N_h$  decreases with increase in  $Sv$ . From Figure 40, it is clear that for any given value of  $N_h$ , as  $Sv$  increases,  $N_f$  decreases.

### Circular microtube:

Figure 41 shows the distribution of dimensionless entropy generation number  $Ns$  for constant values of  $S$ ,  $Sv$ ,  $Z$  and  $Pe$ . Here Brinkman number  $Br$  is chosen as a

parameter ranging from 0.2 to 1.0. From the figure, it is clear that  $N_s$  decreases as we go towards the center of the tube. Also as the value of  $Br$  increases,  $N_s$  also increases for a given value of  $R$ . Figure 42 displays the Bejan number  $Be$  versus  $R$ . As the value of  $Br$  increases,  $Be$  decreases. In Figure 43, Irreversibility ratio  $\Phi$  is plotted versus  $R$ . It can be noted that as the value of  $Br$  increases,  $\Phi$  also increases. Figures 44 and 45 show the dimensionless ratios  $G_f$  and  $G_r$  versus  $R$ . Figure 46 shows the entropy generation due to fluid friction  $N_f$  versus  $R$ . It can be seen that as the value of  $Br$  increases,  $N_f$  increases for a particular value of  $R$ .

In Figure 47,  $N_s$  is plotted versus  $R$  for constant values of  $S$ ,  $Sv$ ,  $Br$  and  $Pe$ . Here relative duct radius  $Z$  is chosen as a parameter ranging from 6.5 to 15. From Figures 48 and 49, it is clear that as the value of  $Z$  increases,  $Be$  decreases and  $\Phi$  increases for any value of  $R$ . Figures 52 and 53 shows  $N_f$  and  $N_h$  versus  $R$  respectively. It can be seen here that as  $Z$  increases, value of  $N_f$  and  $N_h$  also increases. In Figure 54,  $N_s$  is plotted versus  $R$  for constant values of  $S$ ,  $Sv$ ,  $Br$  and  $Z$ . Here Peclet number  $Pe$  is chosen as a parameter ranging from 2 to 10. It can be seen that as the value of  $Pe$  increases,  $N_s$  decreases. From Figures 55 and 56, it is clear that as the value of  $Pe$  increases,  $Be$  decreases and  $\Phi$  increases for any value of  $R$ . Figures 59 and 60 shows  $N_c$  and  $N_h$  versus  $R$  respectively. It can be seen here that as  $Pe$  increases, value of  $N_c$  and  $N_h$  decreases.

In Figure 61,  $N_s$  is plotted versus  $R$  for constant values of  $Pe$ ,  $Sv$ ,  $Br$  and  $Z$ . Here dimensionless joule heating parameter  $S$  is chosen as a parameter ranging from 1 to 16. It can be seen that as the value of  $S$  increases,  $N_s$  also increases. From Figures 62 and 63, it is clear that as the value of  $S$  increases,  $Be$  increases and  $\Phi$  decreases for any value of  $R$ . In Figure 67,  $N_h$  is plotted versus  $R$ . It can be seen here that as  $S$  increases, value of  $N_h$

also increases. In Figure 68,  $N_s$  is plotted versus  $R$  for constant values of  $Pe$ ,  $S$ ,  $Br$  and  $Z$ . Here dimensionless viscous heating parameter  $Sv$  is chosen as a parameter ranging from 1 to 16. It can be seen that as the value of  $Sv$  increases,  $N_s$  decreases. From Figures 69 and 70, it is clear that as the value of  $Sv$  increases,  $Be$  decreases and  $\Phi$  increases for any value of  $R$ . We can see from Figure 74 that  $N_h$  decreases with increase in  $Sv$ .

We have analyzed the nature of various plots for thermally fully developed, electro-osmotically generated flow for a parallel plate microchannel and a circular microtube under constant wall heat flux boundary condition. Similar kind of results can be obtained by applying constant wall temperature boundary condition.

## CHAPTER V

### CONCLUDING REMARKS

We have considered thermally fully developed electro-osmotically generated flow which is established by a voltage potential gradient along the length of a channel or a tube. We have provided an analysis for the entropy generated in a parallel plate microchannel and a circular microtube. The boundary condition considered in our case is constant wall heat flux. We have identified five different variables namely, (i) dimensionless joule heating parameter, (ii) dimensionless viscous heating parameter, (iii) relative duct radius, (iv) Peclet number and (v) Brinkman number from the dimensionless entropy generation number equation. We have analyzed the nature of various results for dimensionless entropy generation number, Bejan number, Irreversibility ratio, entropy generation due to fluid friction, entropy generation due to heat transfer in the axial and transverse direction etc. and discussed the effects of each of those five variables on these parameters for both the configurations. We have coded the required MATLAB programs used to generate the plots in the present work and they are given in the appendix.

## BIBLIOGRAPHY

- [1] P. Gravensen, J. Branebjerg, O.S. Jensen, Microfluidics-A review, *J. Micromech. Microeng.* 3 (1993) 168-182.
- [2] L. Bousse, C. Cohen, T.Nikiforov, A. Chow, A.R. KopffSill, R. Dubrow, J.W. Parce, Electrokinetically controlled microfluidic analysis systems, *Annu. Rev. Biophys. Bio-mol. Struct.* 29 (2000) 155-181.
- [3] P.K. Dasgupta, L. Shaorong, Electroosmosis: a reliable fluid propulsion system for flow injection analysis, *Anal. Chem* 66 (1994) 1792-1798.
- [4] S. Arulanandam, L. Dongqing Liquid transport in rectangular microchannels by electro-osmotic pumping *Coloids Surf . A* 161 (2000) 89-102.
- [5] F.F. Reuss, Charge-induced flow, *Proc. Imp. Soc. Natural. Moscow* 3 (1809) 327-344.
- [6] D. Maynes, B.W. Webb, The effect of viscous dissipation in thermally fully-developed electro-osmotic heat transfer in microchannels, *International Journal of Heat and Mass Transfer* 47 (2004) 987–999.
- [7] R.F. Probstein, *Physicochemical Hydrodynamics*, second ed., Wiley, New York, 1994.
- [8] C.L. Rice, R. Whitehead, Electrokinetic flow in a narrow cylindrical capillary, *J. Phys. Chem.* 69 (1965) 4017–4024.
- [9] D. Burgreen, F.R. Nakache, Electrokinetic flow in ultrafine capillary slits, *J. Phys. Chem.* 68 (1964) 1084-1091.

- [10] T.L. Sounart, J.C. Baygents, Electrically-driven fluid motion in channels with streamwise gradients of electrical conductivity, *Colloids Surf. A* 195(2001) 59-75.
- [11] C. Yang, C.B. Ng, V. Chan, Transient analysis of electroosmotic flow in a slit microchannel, *J. Colloid Interface Sci.* 248 (2002) 524-527.
- [12] R.J. Yang, L.M. fu, C.C. Hwang, Electroosmotic entry flow in a microchannel, *J. Colloid Interface Sci.* 244 (2001) 173-179.
- [13] D. Ross, T.J. Johnson, L.E. Locascio, Imaging of electro-osmotic flow in plastic microchannels, *Anal. Chem.* 73 (2001) 2509-2515.
- [14] T. Tsuda, M. Ikeda, Observation of flow profiles in electroosmosis in a rectangular capillary, *J.Chromatogr.* 632 (1993) 201-207.
- [15] C. Yang, D. Li, Analysis of electrokinetic effects on the liquid flow in rectangular microchannels, *Colloids Surf.* 143 (1998) 339-353.
- [16] L.N. Tao, On some laminar forced-convection problems, *ASME J. Heat Transfer* 83 (1961) 466-472.
- [17] J.H. Knox, Thermal effects and band spreading in capillary electro-separation, *Chromatographia* 26 (1998) 329-337.
- [18] D. Maynes, B. Webb, Fully developed electro-osmotic heat transfer in microchannel, *International Journal of Heat & Mass Transfer* 46(2003)1359–1369
- [19] D. Maynes, B. Webb, Fully developed thermal transport in combined pressure & electro-osmotic driven flow in microchannels, in: Proceedings of the 6<sup>th</sup> ASME - JSME Thermal Engineering Joint Conference, Paper TED-AJ03-343, 2003.
- [20] C.J. Tranter, Bessel functions with some physical applications, first ed., Hart Publishing Company, New York City, 1969.

## I. Variables used in the MATLAB Programs

<b>Variables used in equations</b>	<b>Variables used in programs</b>
Dimensionless joule heating parameter ( $S$ )	S
Dimensionless viscous heating parameter ( $S_v$ )	S_v
Relative duct radius ( $Z$ )	Z
Peclet number ( $Pe$ )	Pe
Wall heat flux ( $q''_w$ )	q
channel hydraulic diameter ( $Dh$ )	Dh
Entropy generation due to heat transfer in the transverse direction ( $N_y$ )	Ny
Entropy generation due to heat transfer in the axial direction ( $N_c$ )	Nc
Entropy generation due to heat transfer in the axial and transverse direction ( $N_h$ )	Nh
Entropy generation due to fluid friction ( $N_f$ )	Nf
Dimensionless entropy generation number ( $N_s$ )	Ns
Irreversibility ratio ( $\Phi$ )	Phi
Bejan number ( $Be$ )	Be
G_axial ( $G_c$ )	Gc
G_fluid friction ( $G_f$ )	Gf

G_heat flux ( $G_H$ )	Gh
G_radial ( $G_R$ )	Gr
Brinkman number ( $Br$ )	Br
Normalized wall-normal coordinate ( $Y = y/a$ )	Y
Normalized radial coordinate ( $R = r/a$ )	R

**FIGURES FOR**  
**PARALLEL PLATE MICROCHANNEL**

Figure 3. Ns Vs Y for S=1; Sv=1; Z=1; Pe=10 and Br=0.2, 0.4, 0.6, 0.8 & 1.0

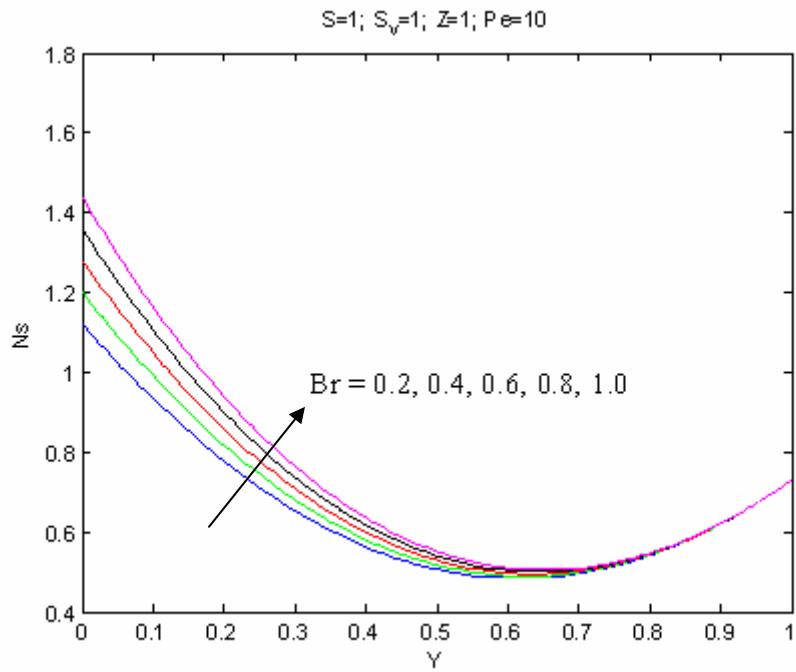


Figure 4. Be Vs Y for S=1; Sv=1; Z=1; Pe=10 and Br=0.2, 0.4, 0.6, 0.8 & 1.0

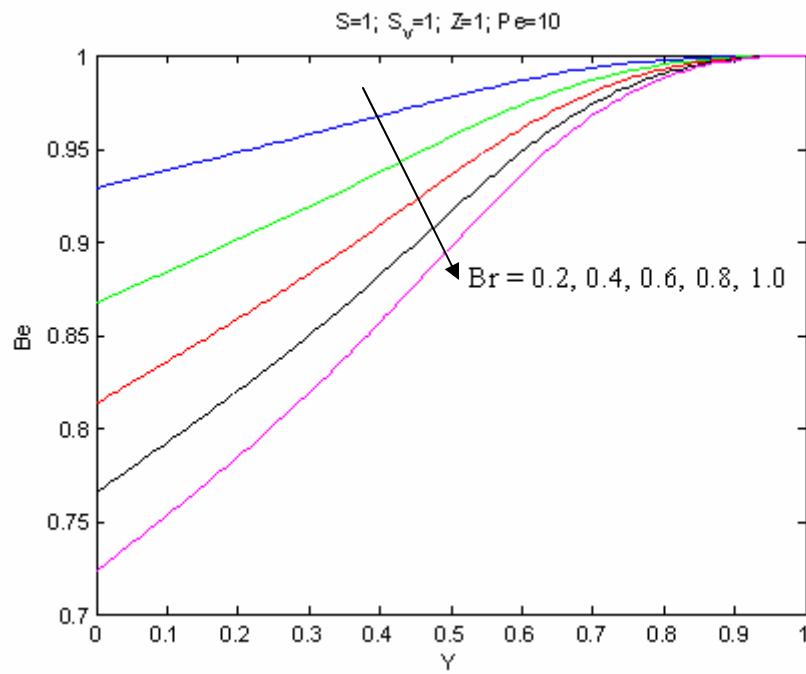


Figure 5.  $\Phi$  Vs Y for  $S=1$ ;  $S_v=1$ ;  $Z=1$ ;  $Pe=10$  and  $Br=0.2, 0.4, 0.6, 0.8 \& 1.0$

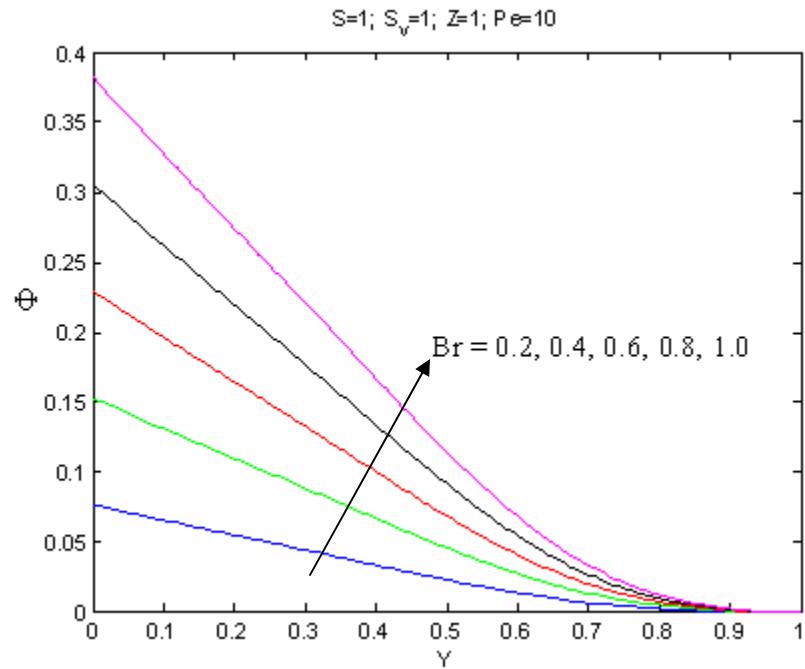


Figure 6.  $G_f$  Vs Y for  $S=1$ ;  $S_v=1$ ;  $Z=1$ ;  $Pe=10$  and  $Br=0.2, 0.4, 0.6, 0.8 \& 1.0$

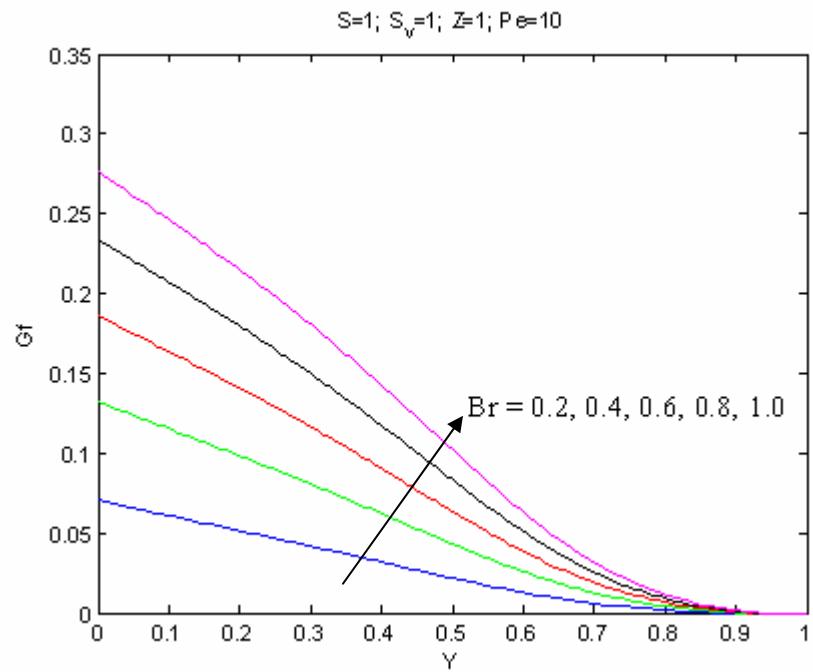


Figure 7. Gh Vs Y for S=1; Sv=1; Z=1; Pe=10 and Br=0.2, 0.4, 0.6, 0.8 & 1.0

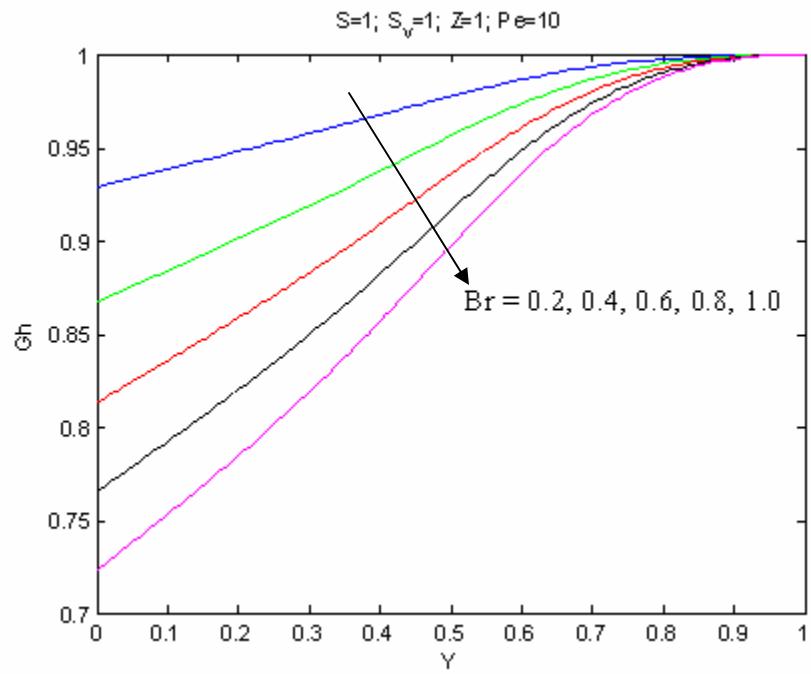


Figure 8. Nf Vs Y for S=1; Sv=1; Z=1; Pe=10 and Br=0.2, 0.4, 0.6, 0.8 & 1.0

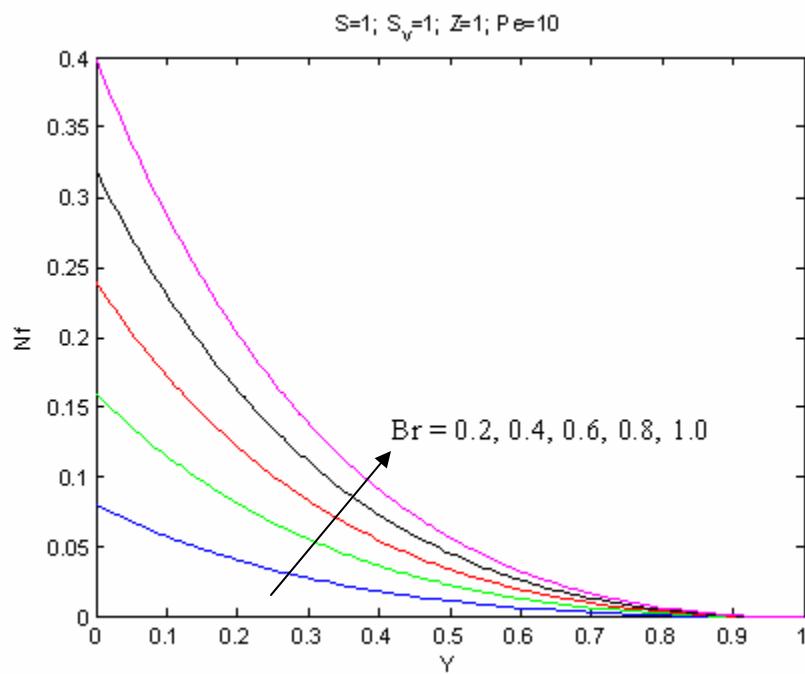


Figure 9.  $N_h$  Vs  $N_f$  for  $S=1$ ;  $S_v=1$ ;  $Z=1$ ;  $Pe=10$  and  $Br=0.2, 0.4, 0.6, 0.8 & 1.0$

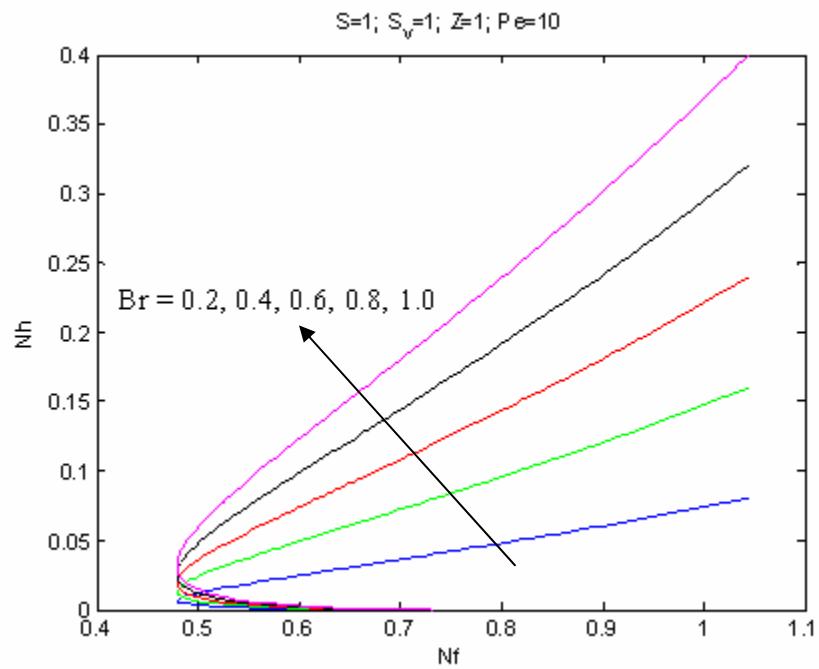


Figure 10.  $N_s$  Vs  $Y$  for  $S=1$ ;  $S_v=1$ ;  $Br=1$ ;  $Pe=10$  and  $Z=6.5, 7.5, 10, 12.5 & 15$

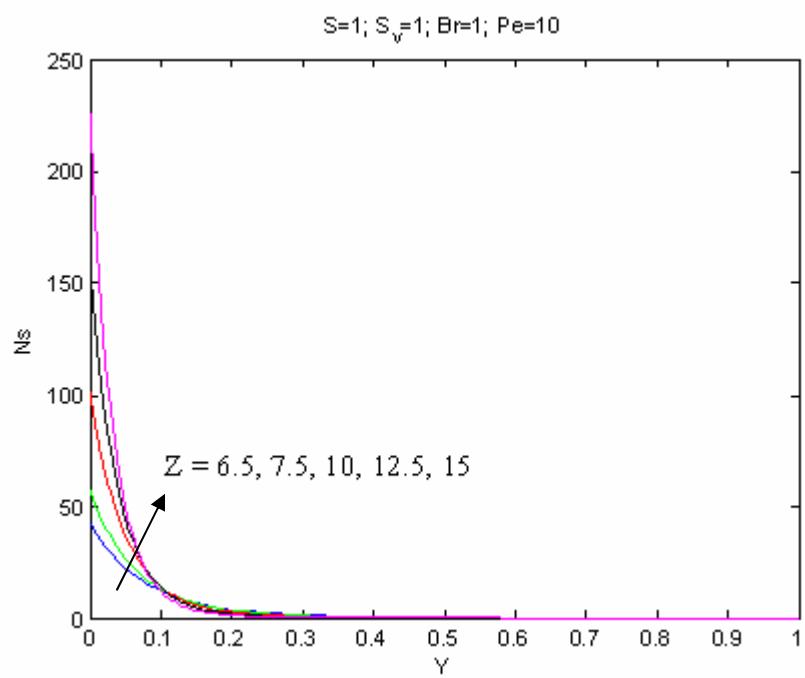


Figure 11. Be Vs Y for S=1; Sv=1; Br=1; Pe=10 and Z=6.5, 7.5, 10, 12.5 & 15

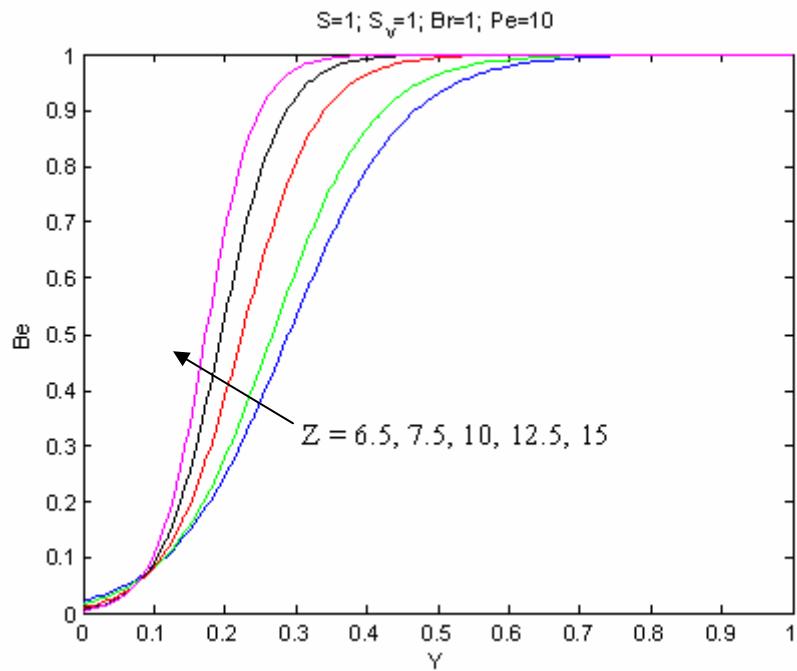


Figure 12.  $\Phi$  Vs Y for S=1; Sv=1; Br=1; Pe=10 and Z=6.5, 7.5, 10, 12.5 & 15

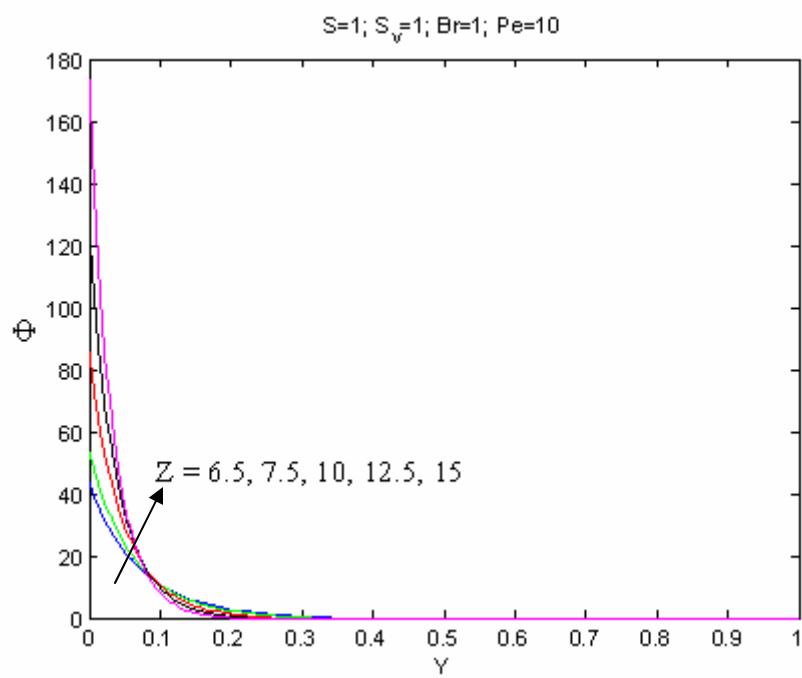


Figure 13. Gf Vs Y for S=1; Sv=1; Br=1; Pe=10 and Z=6.5, 7.5, 10, 12.5 & 15

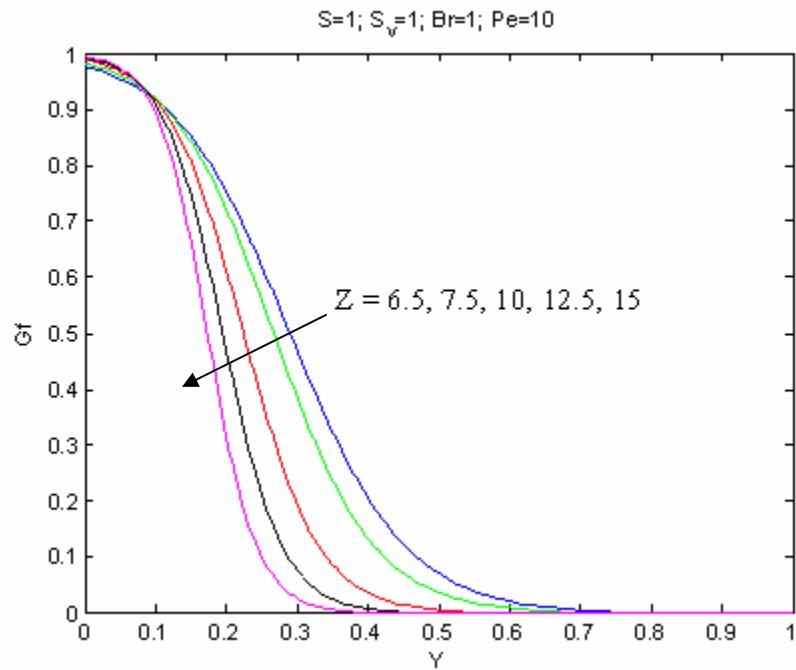


Figure 14. Gh Vs Y for S=1; Sv=1; Br=1; Pe=10 and Z=6.5, 7.5, 10, 12.5 & 15

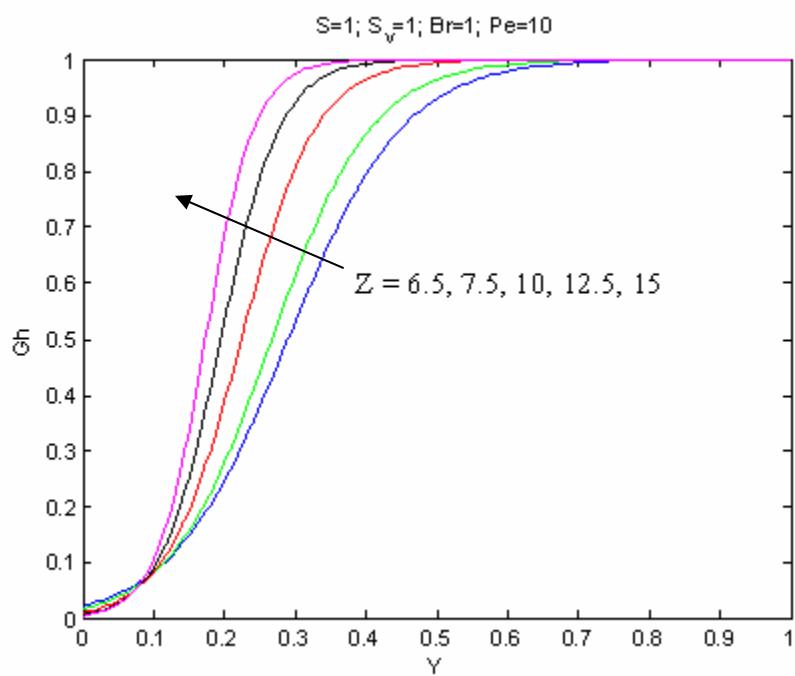


Figure 15. Nf Vs Y for S=1; Sv=1; Br=1; Pe=10 and Z=6.5, 7.5, 10, 12.5 & 15

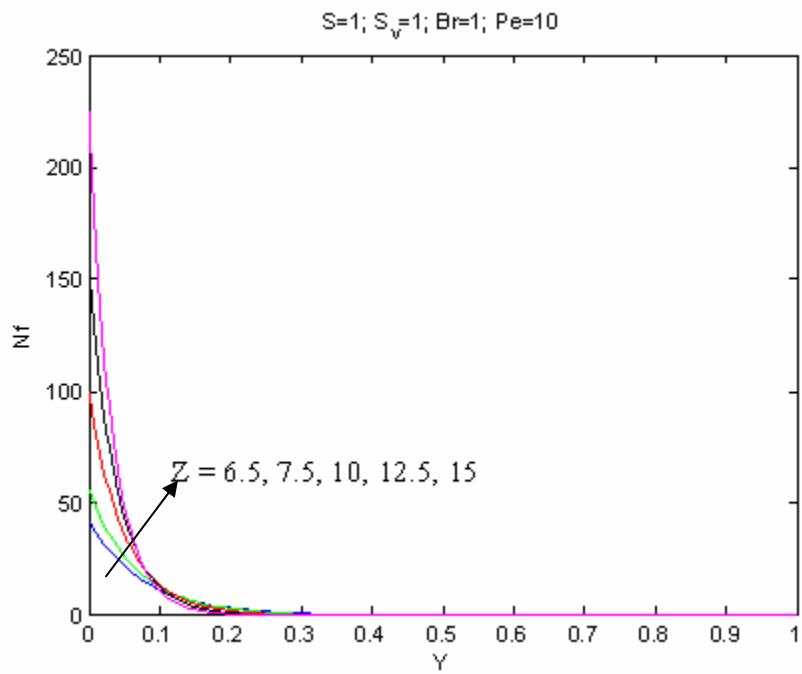


Figure 16. Nh Vs Y for S=1; Sv=1; Br=1; Pe=10 and Z=6.5, 7.5, 10, 12.5 & 15

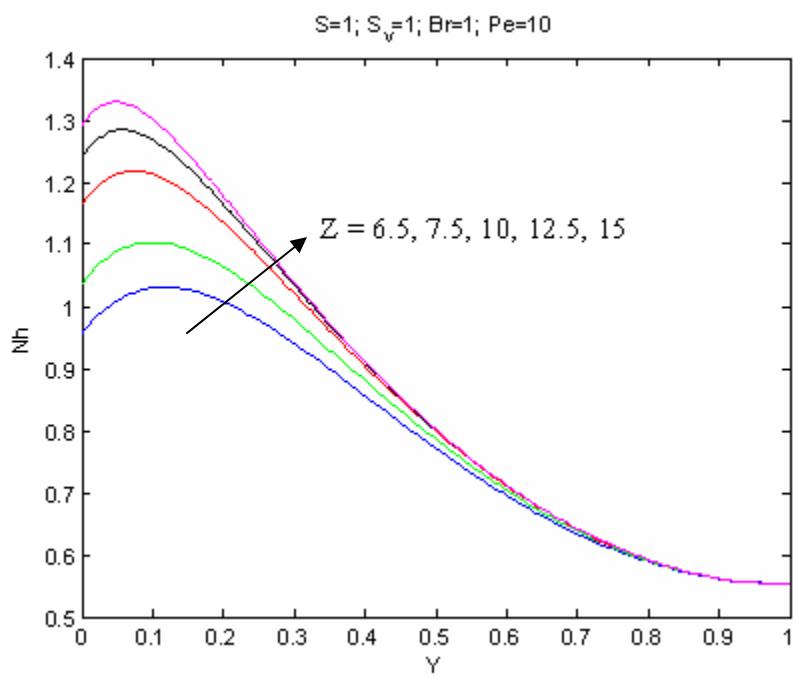


Figure 17. Nh Vs Nf for S=1; Sv=1; Br=1; Pe=10 and Z=6.5, 7.5, 10, 12.5 & 15

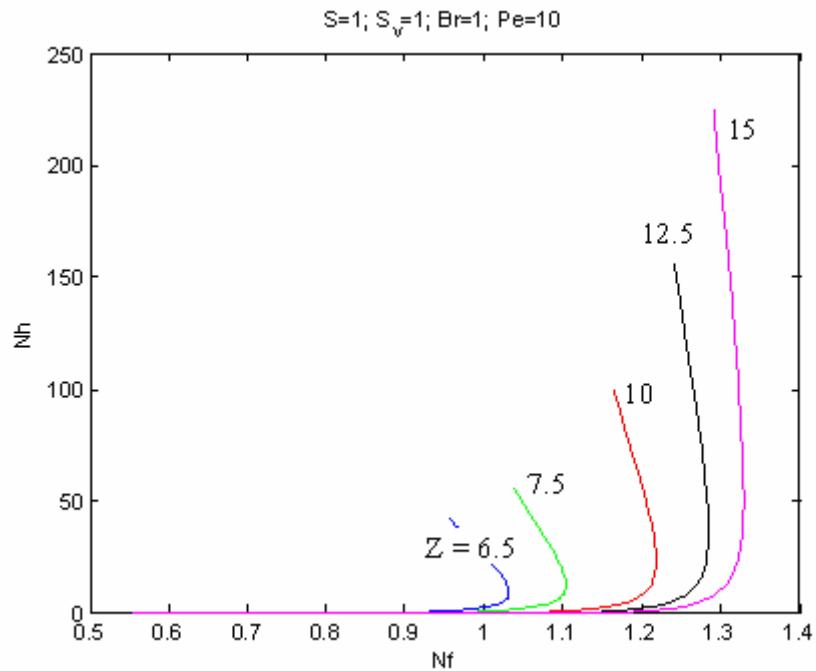


Figure 18. Ns Vs Y for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

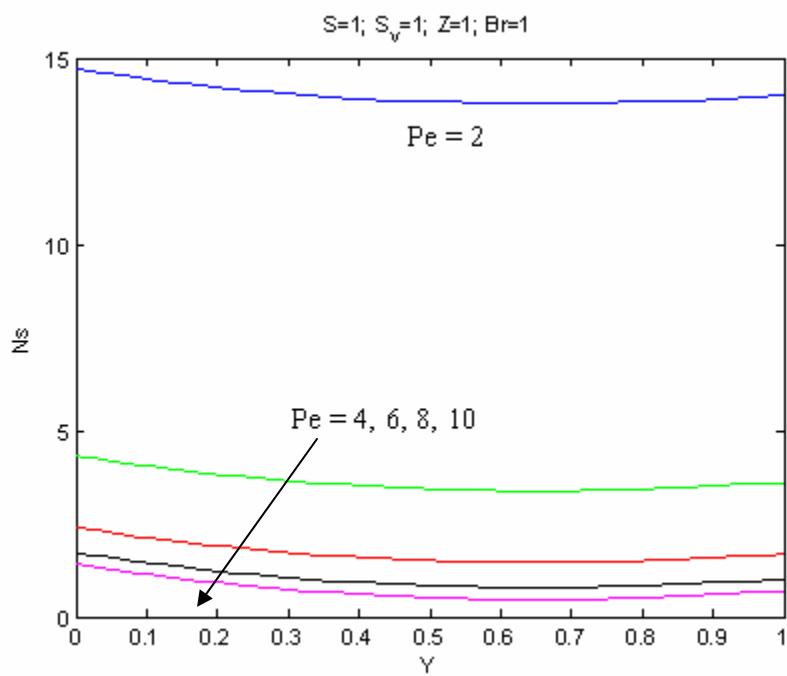


Figure 19. Be Vs Y for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

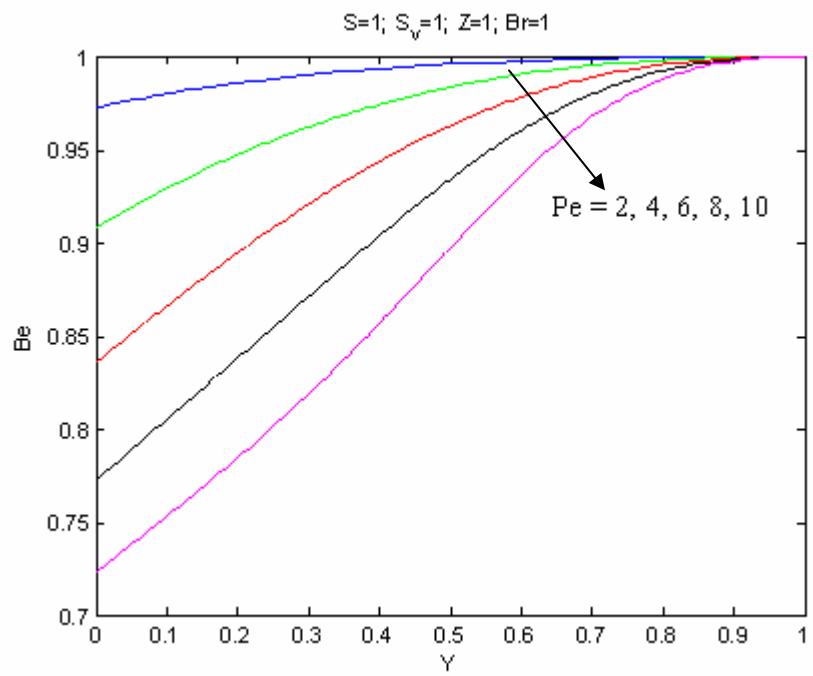


Figure 20.  $\Phi$  Vs Y for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

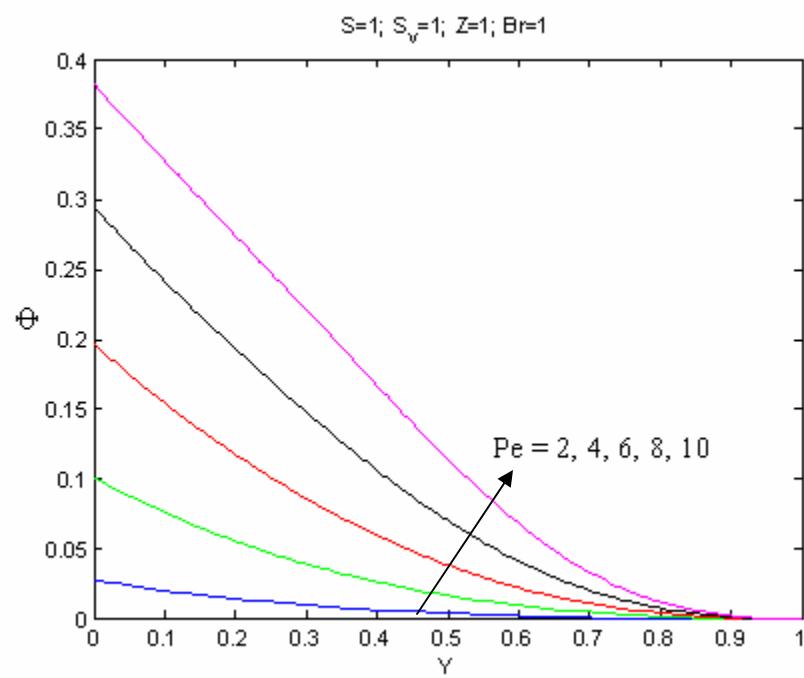


Figure 21. Gf Vs Y for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

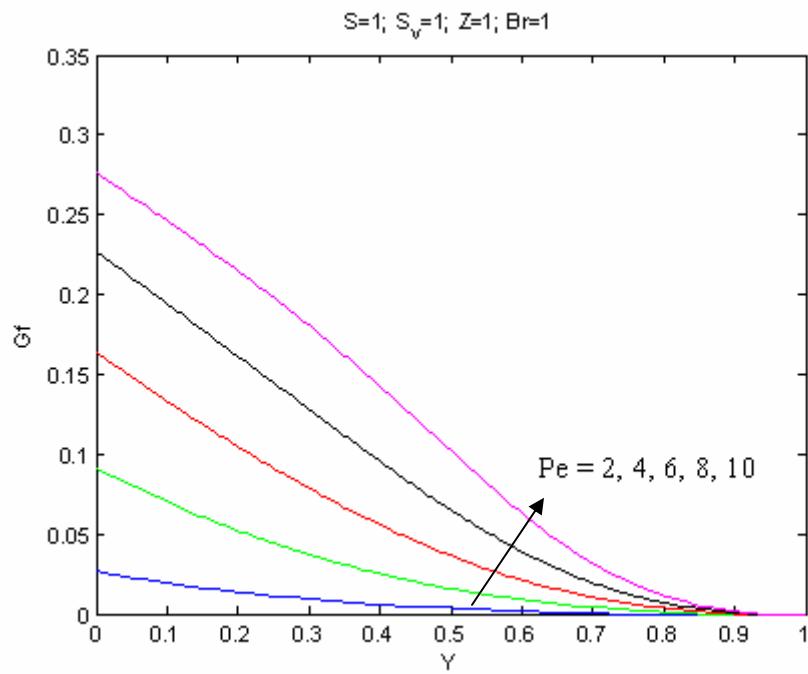


Figure 22. Gh Vs Y for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

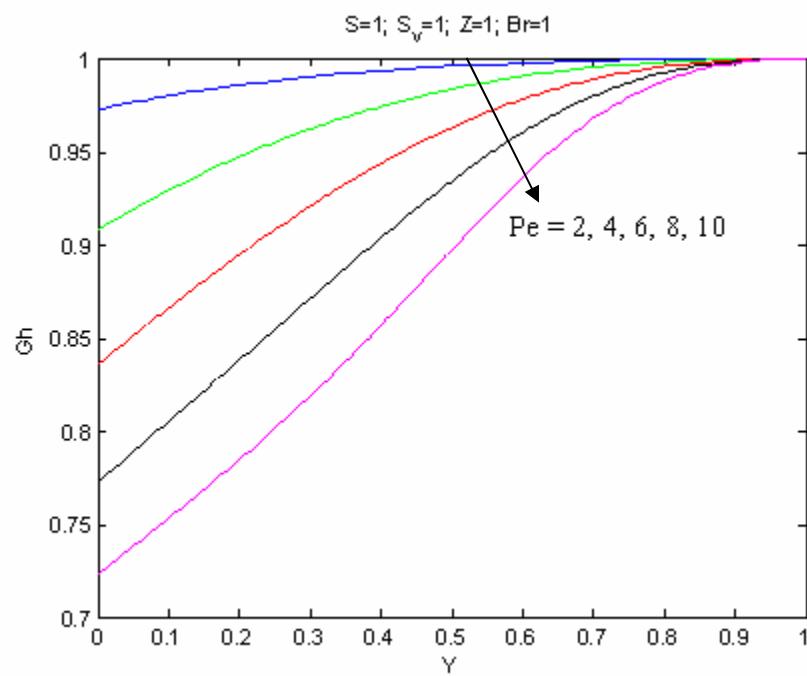


Figure 23. Nc Vs Y for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

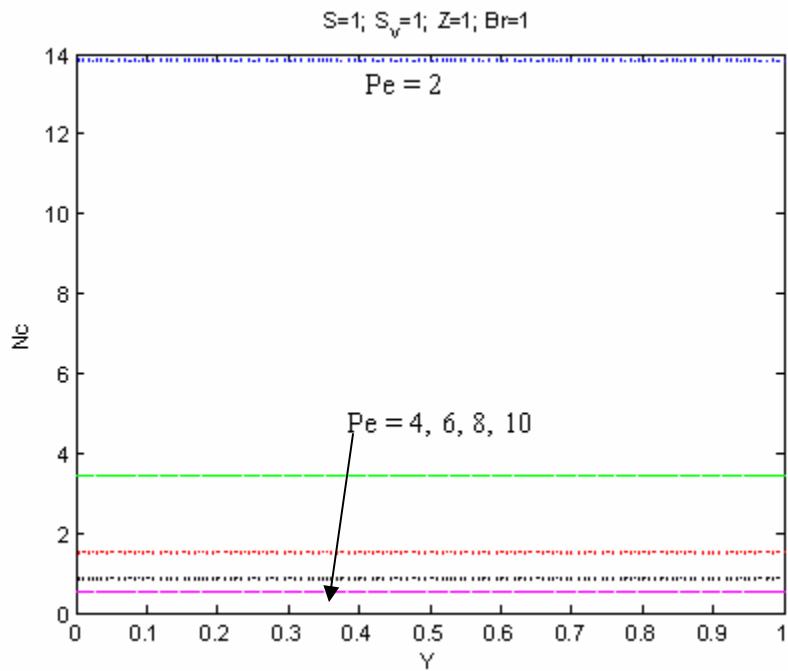


Figure 24. Nh Vs Y for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

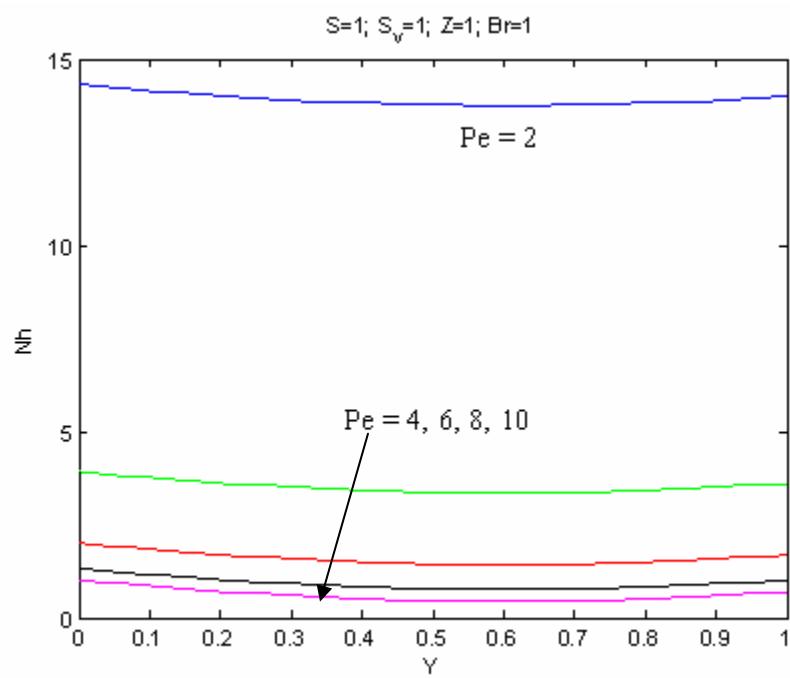


Figure 25. Nh Vs Nf for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

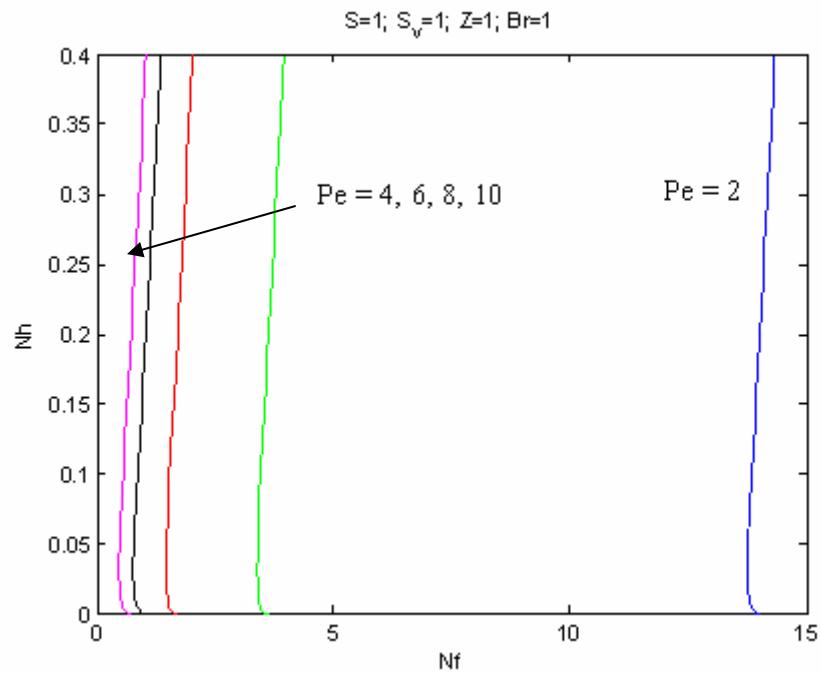


Figure 26. Ns Vs Y for Sv=1; Z=1; Br=1; Pe=2.5 and S=1, 2, 3, 4 & 5

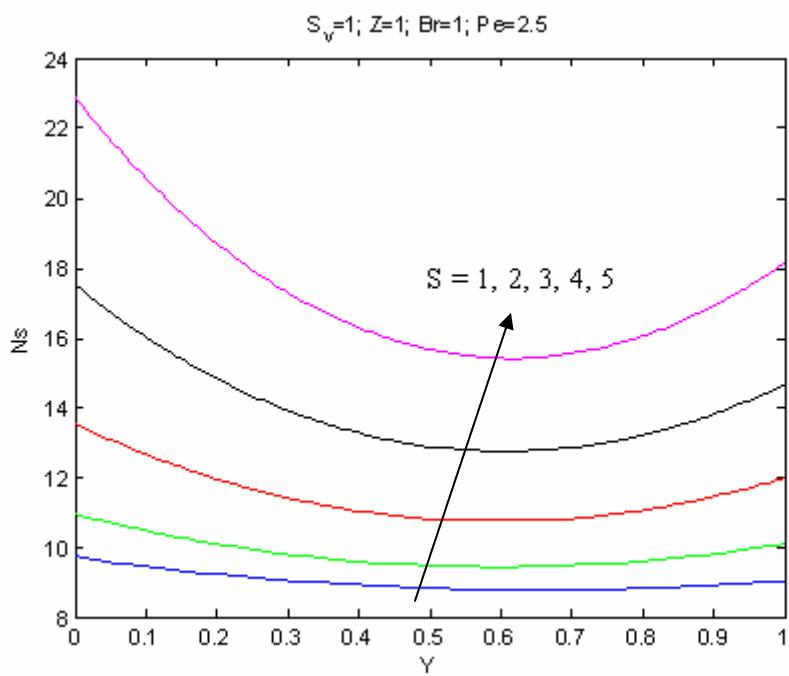


Figure 27. Be Vs Y for  $S_v=1$ ;  $Z=1$ ;  $Br=1$ ;  $Pe=2.5$  and  $S=1, 2, 3, 4 \& 5$

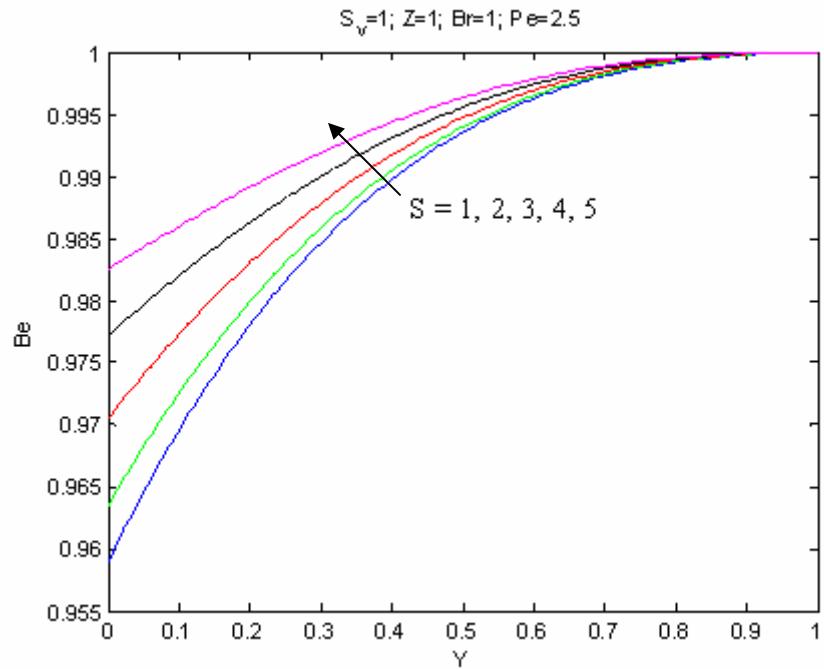


Figure 28.  $\Phi$  Vs Y for  $S_v=1$ ;  $Z=1$ ;  $Br=1$ ;  $Pe=2.5$  and  $S=1, 2, 3, 4 \& 5$

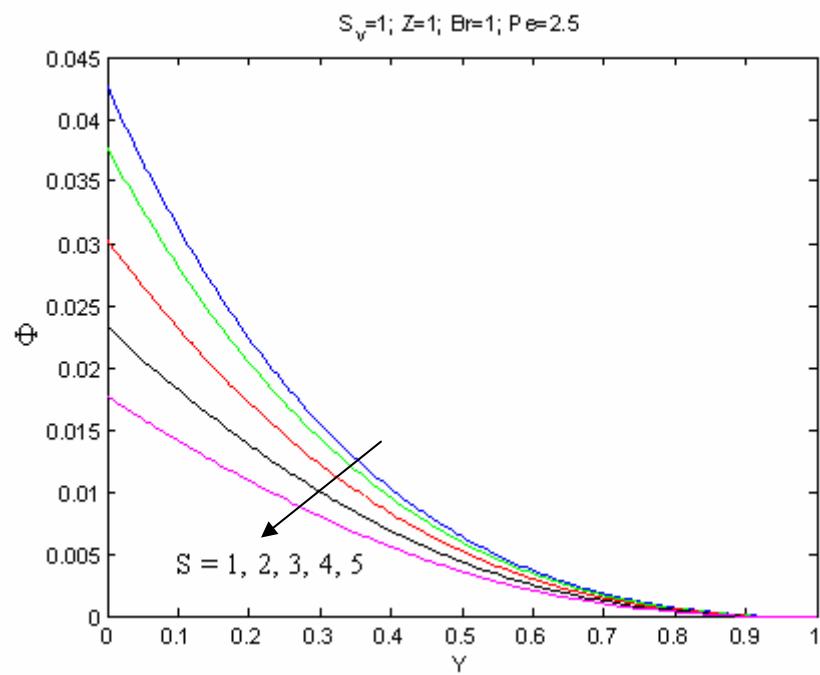


Figure 29. Gf Vs Y for Sv=1; Z=1; Br=1; Pe=2.5 and S=1, 2, 3, 4 & 5

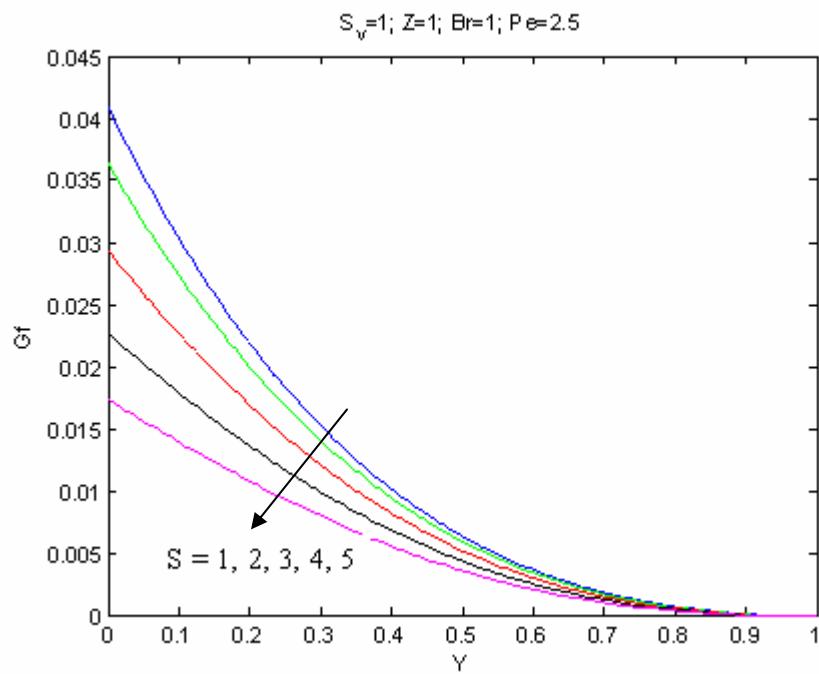


Figure 30. Gh Vs Y for Sv=1; Z=1; Br=1; Pe=2.5 and S=1, 2, 3, 4 & 5

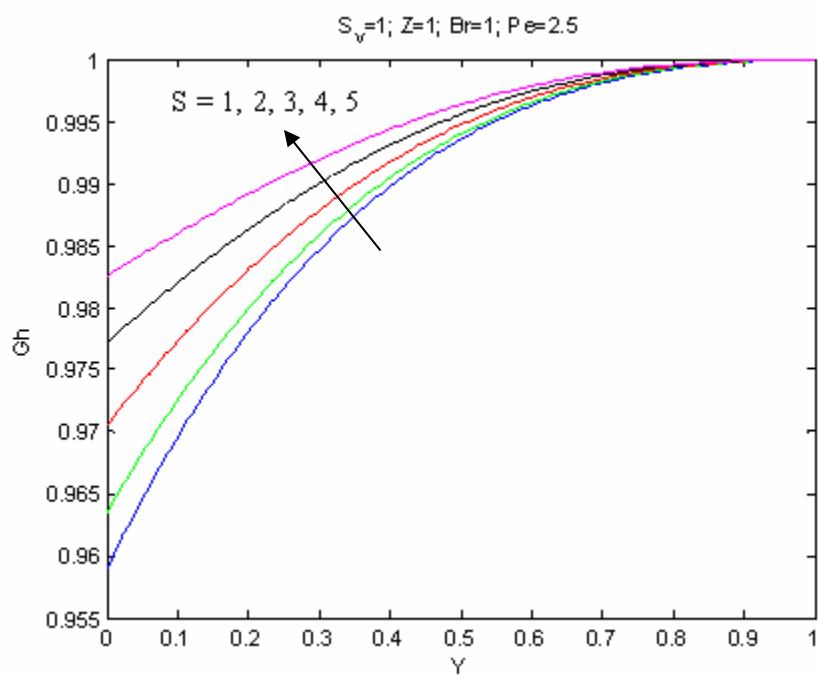


Figure 31. Nh Vs Y for  $S_v=1$ ;  $Z=1$ ;  $Br=1$ ;  $Pe=2.5$  and  $S=1, 2, 3, 4 \& 5$

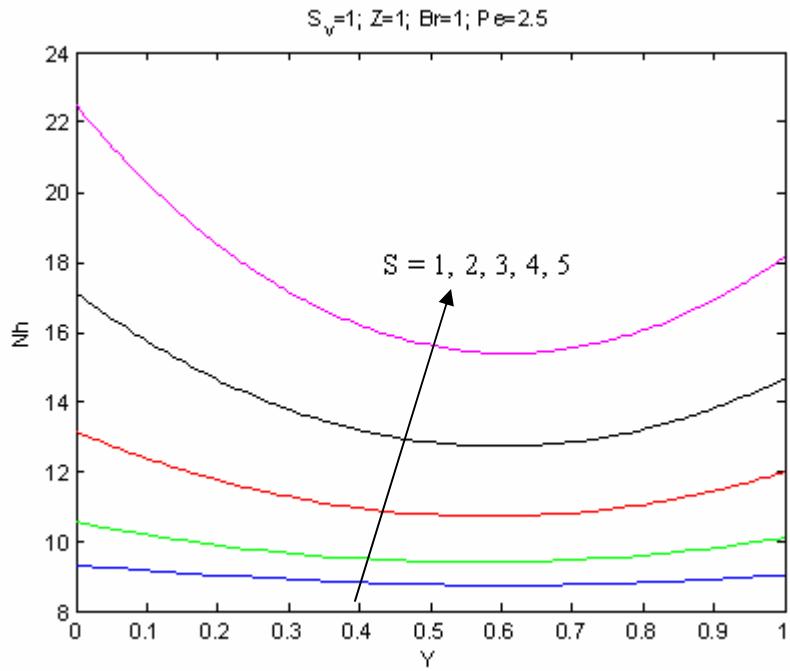


Figure 32. Nh Vs Nf for  $S_v=1$ ;  $Z=1$ ;  $Br=1$ ;  $Pe=2.5$  and  $S=1, 2, 3, 4 \& 5$

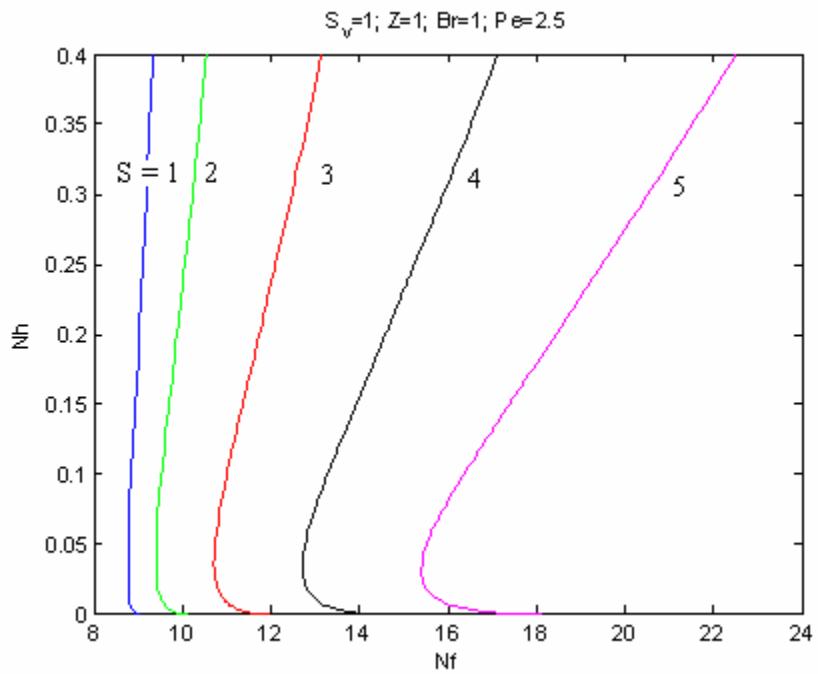


Figure 33. Ns Vs Y for S=1.5; Z=3.5; Br=0.5; Pe=5.5 and Sv=1, 2, 3, 4 & 5

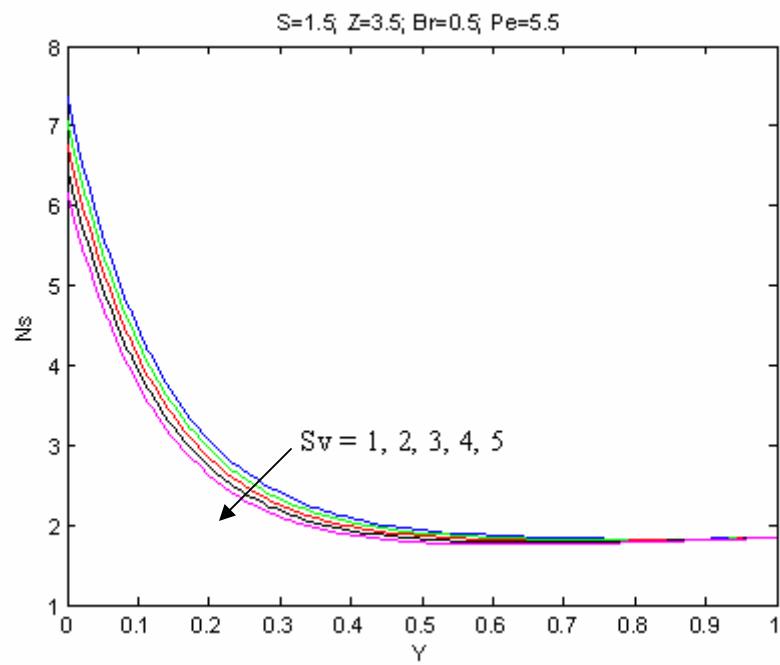


Figure 34. Be Vs Y for S=1.5; Z=3.5; Br=0.5; Pe=5.5 and Sv=1, 2, 3, 4 & 5

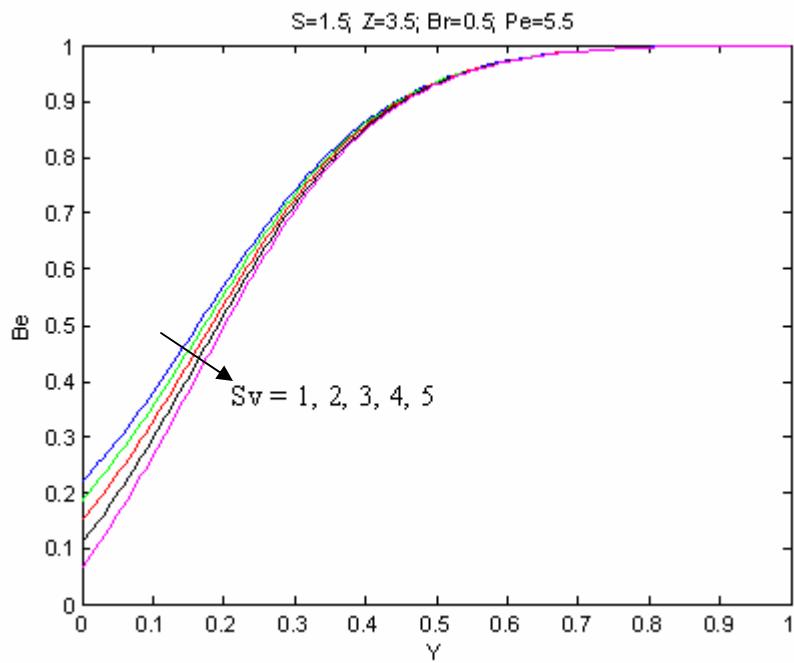


Figure 35.  $\Phi$  Vs  $Y$  for  $S=1.5$ ;  $Z=3.5$ ;  $Br=0.5$ ;  $Pe=5.5$  and  $Sv=1, 2, 3, 4 \& 5$

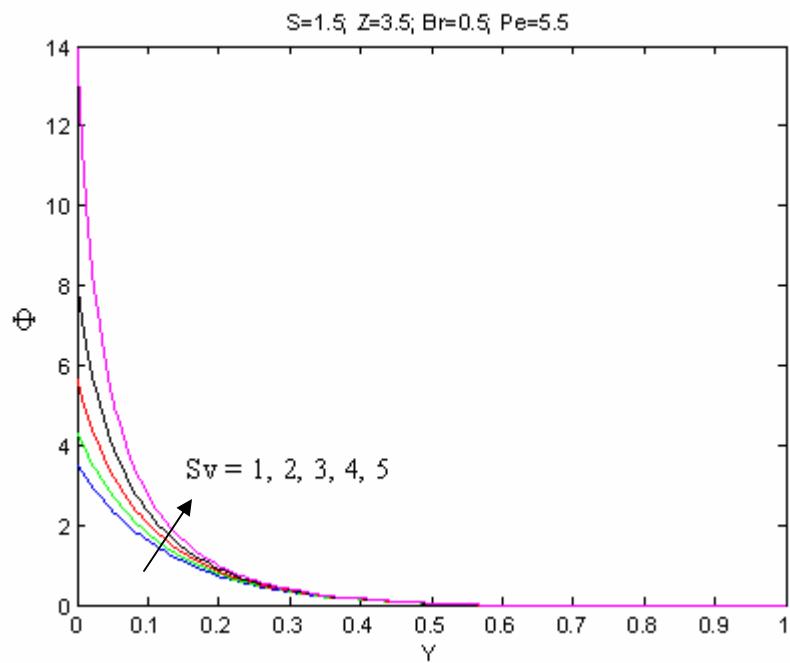


Figure 36.  $Gf$  Vs  $Y$  for  $S=1.5$ ;  $Z=3.5$ ;  $Br=0.5$ ;  $Pe=5.5$  and  $Sv=1, 2, 3, 4 \& 5$

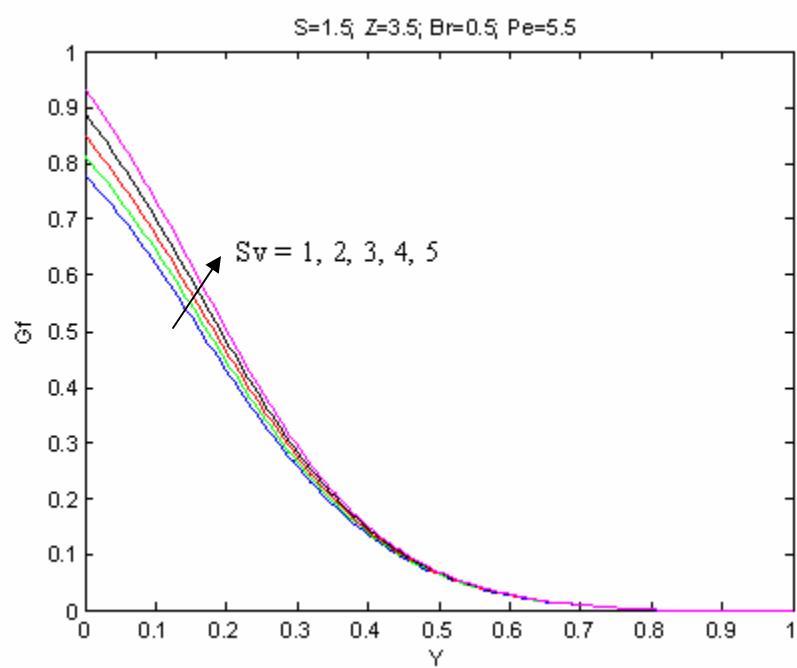


Figure 37. Gh Vs Y for S=1.5; Z=3.5; Br=0.5; Pe=5.5 and Sv=1, 2, 3, 4 & 5

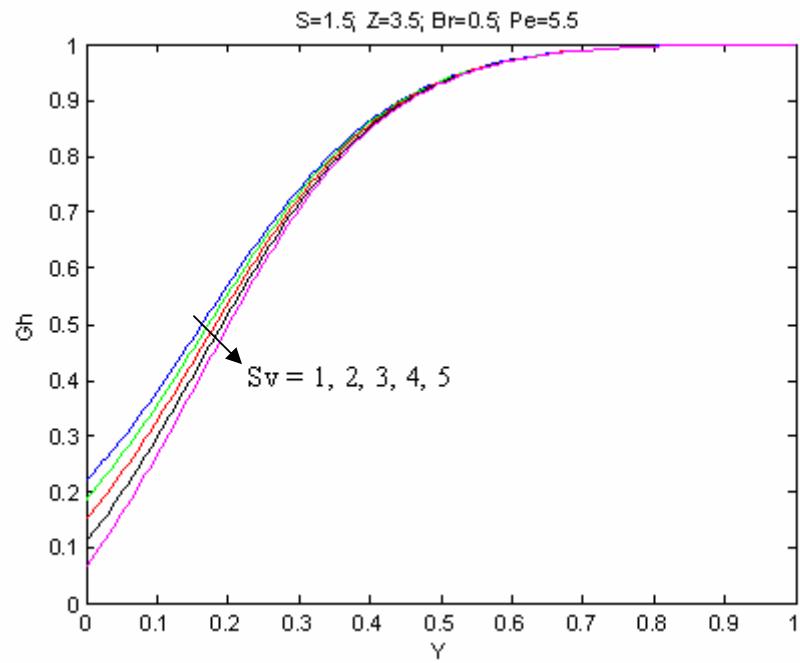


Figure 38. Nf Vs Y for S=1.5; Z=3.5; Br=0.5; Pe=5.5 and Sv=1, 2, 3, 4 & 5

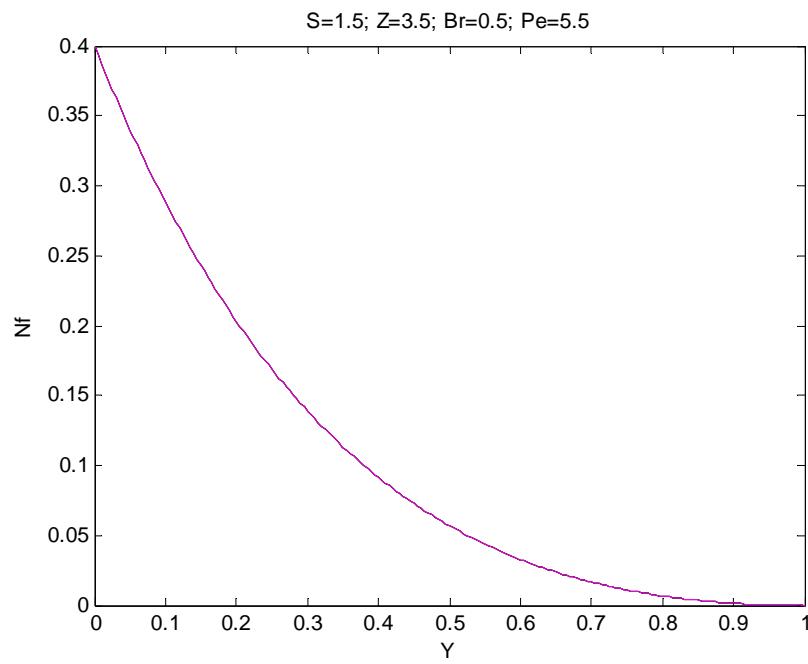


Figure 39. Nh Vs Y for S=1.5; Z=3.5; Br=0.5; Pe=5.5 and Sv=1, 2, 3, 4 & 5

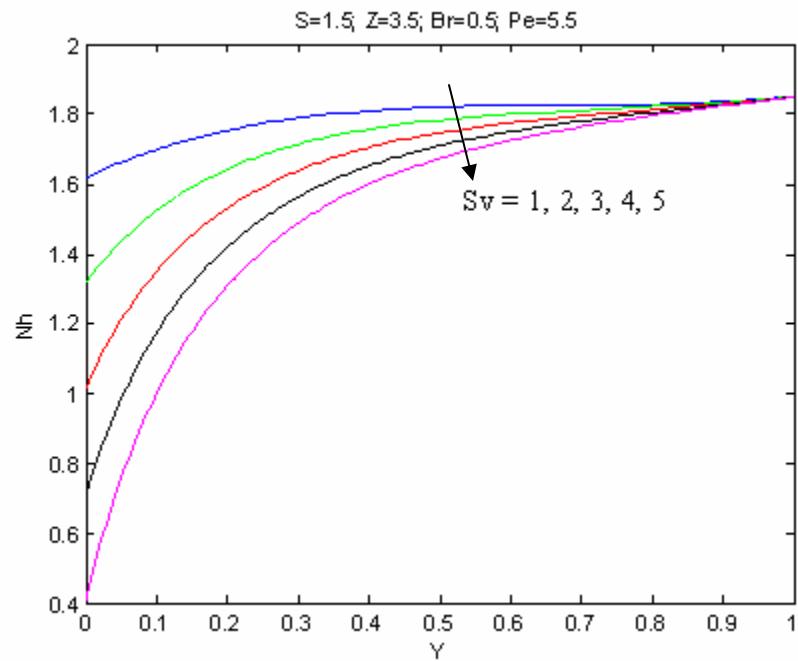
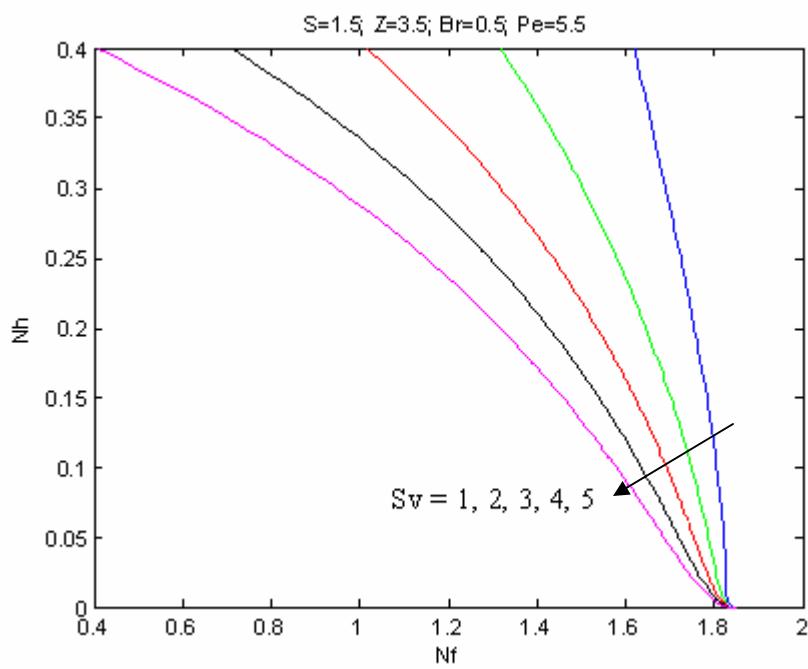


Figure 40. Nh Vs Nf for S=1.5; Z=3.5; Br=0.5; Pe=5.5 and Sv=1, 2, 3, 4 & 5



**FIGURES FOR  
CIRCULAR MICROTUBE**

Figure 41. Ns Vs R for S=1; Sv=1; Z=1; Pe=10 and Br=0.2, 0.4, 0.6, 0.8 & 1.0

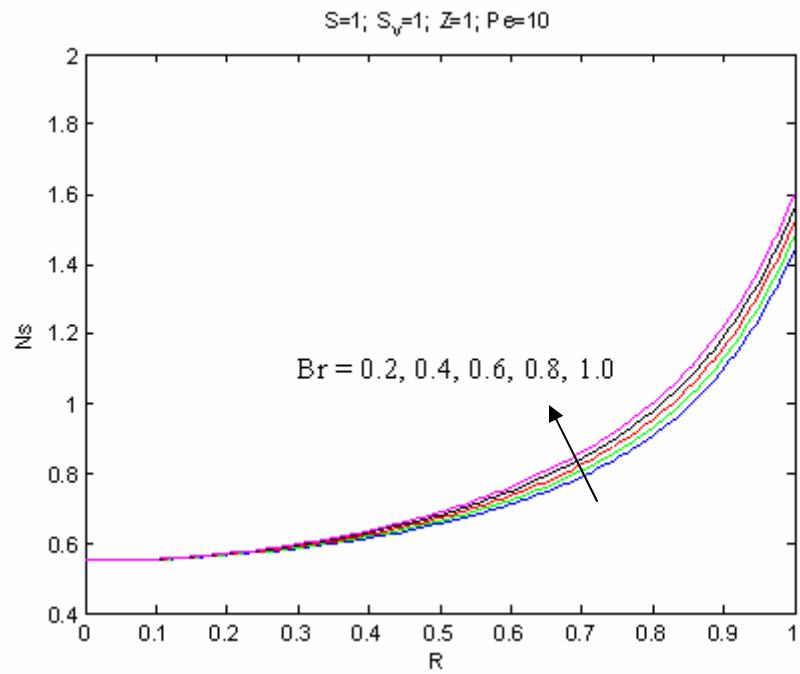


Figure 42. Be Vs R for S=1; Sv=1; Z=1; Pe=10 and Br=0.2, 0.4, 0.6, 0.8 & 1.0

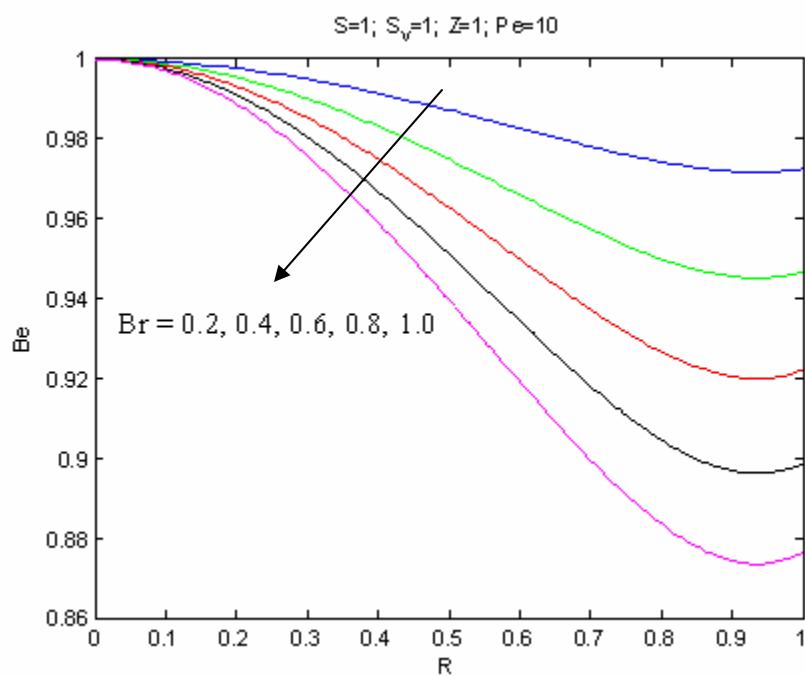


Figure 43.  $\Phi$  Vs R for  $S=1; Sv=1; Z=1; Pe=10$  and  $Br=0.2, 0.4, 0.6, 0.8 & 1.0$

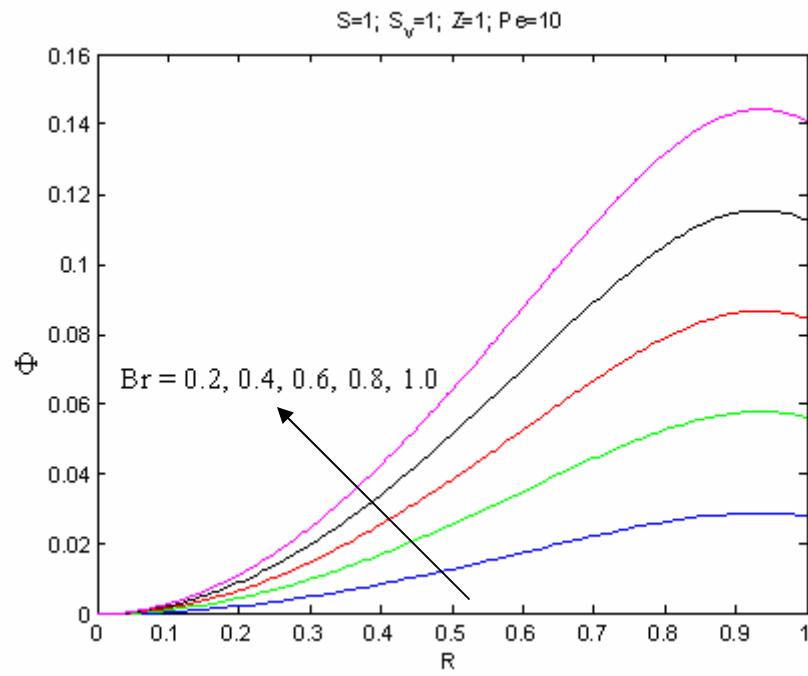


Figure 44.  $G_f$  Vs R for  $S=1; Sv=1; Z=1; Pe=10$  and  $Br=0.2, 0.4, 0.6, 0.8 & 1.0$

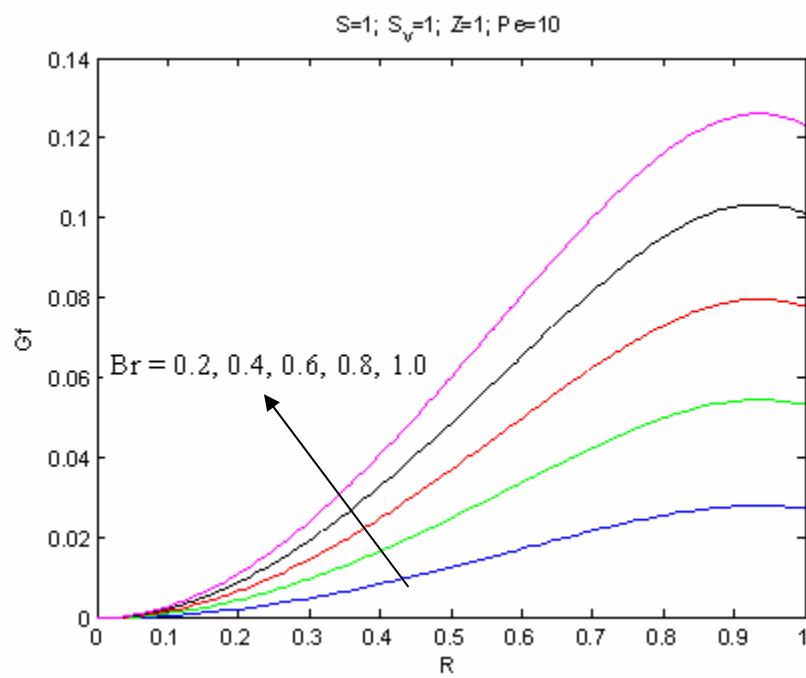


Figure 45. Gr Vs R for S=1; Sv=1; Z=1; Pe=10 and Br=0.2, 0.4, 0.6, 0.8 & 1.0

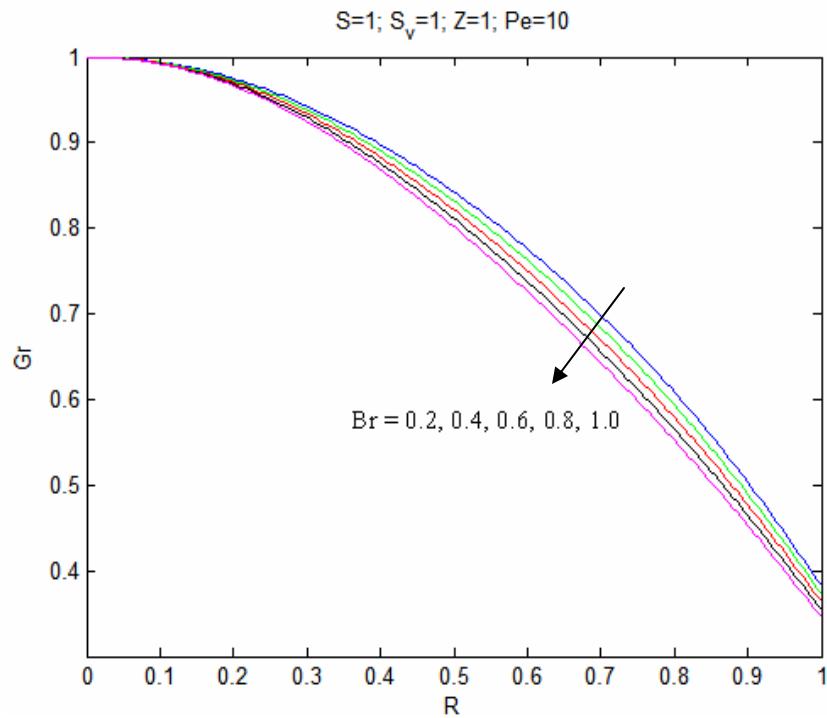


Figure 46. Nf Vs R for S=1; Sv=1; Z=1; Pe=10 and Br=0.2, 0.4, 0.6, 0.8 & 1.0

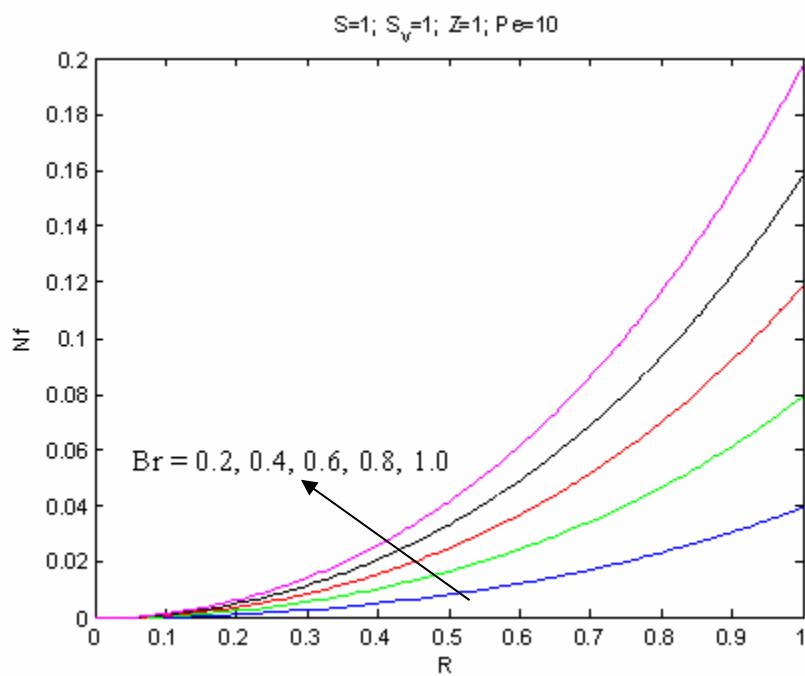


Figure 47.  $N_s$  Vs  $R$  for  $S=1$ ;  $S_v=1$ ;  $Br=1$ ;  $Pe=10$  and  $Z=6.5, 7.5, 10, 12.5 \& 15$

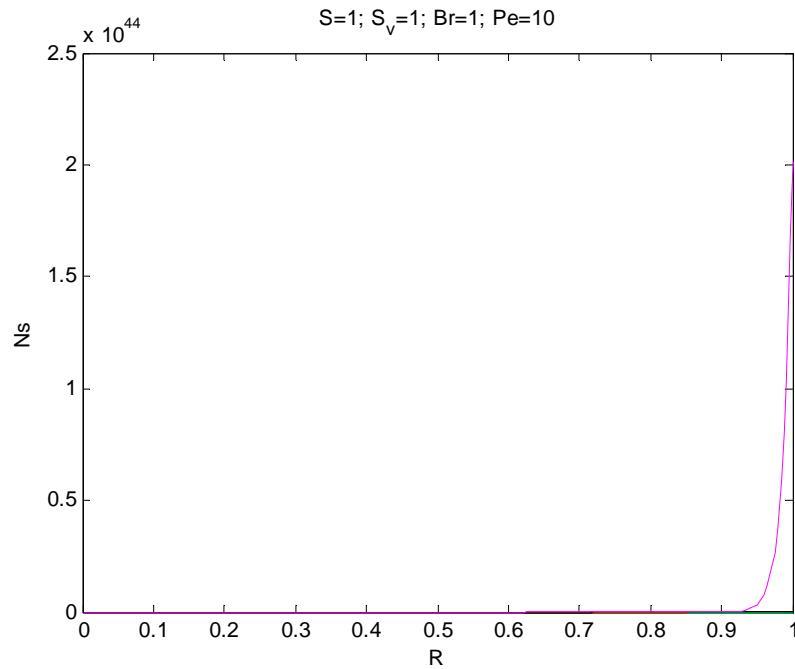


Figure 48.  $B_e$  Vs  $R$  for  $S=1$ ;  $S_v=1$ ;  $Br=1$ ;  $Pe=10$  and  $Z=6.5, 7.5, 10, 12.5 \& 15$

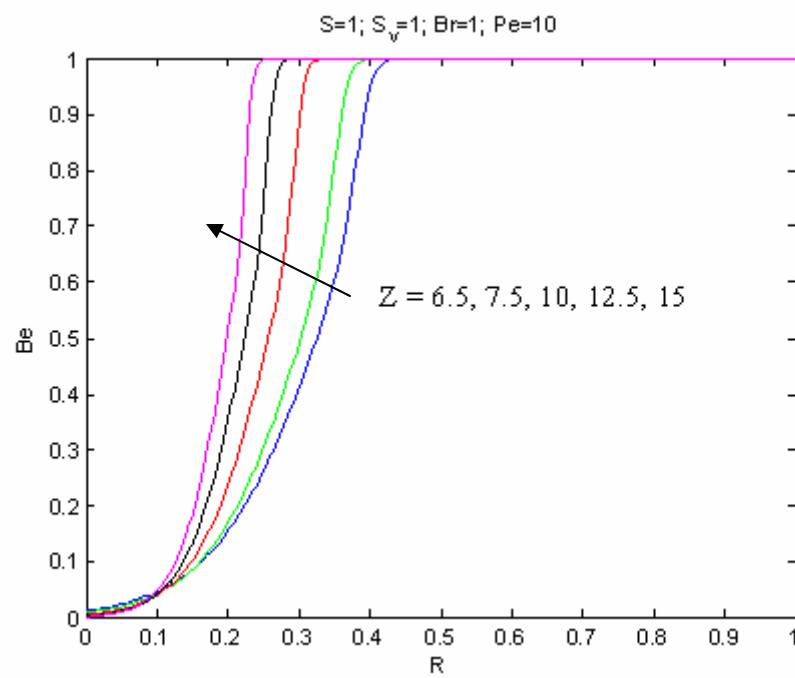


Figure 49.  $\Phi$  Vs R for  $S=1$ ;  $S_v=1$ ;  $Br=1$ ;  $Pe=10$  and  $Z=6.5, 7.5, 10, 12.5 \& 15$

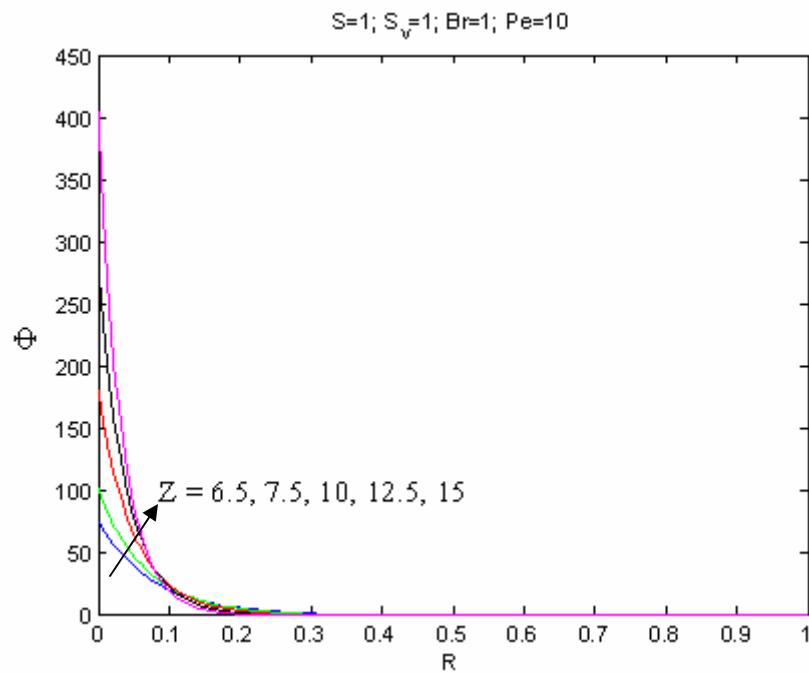


Figure 50.  $G_f$  Vs R for  $S=1$ ;  $S_v=1$ ;  $Br=1$ ;  $Pe=10$  and  $Z=6.5, 7.5, 10, 12.5 \& 15$

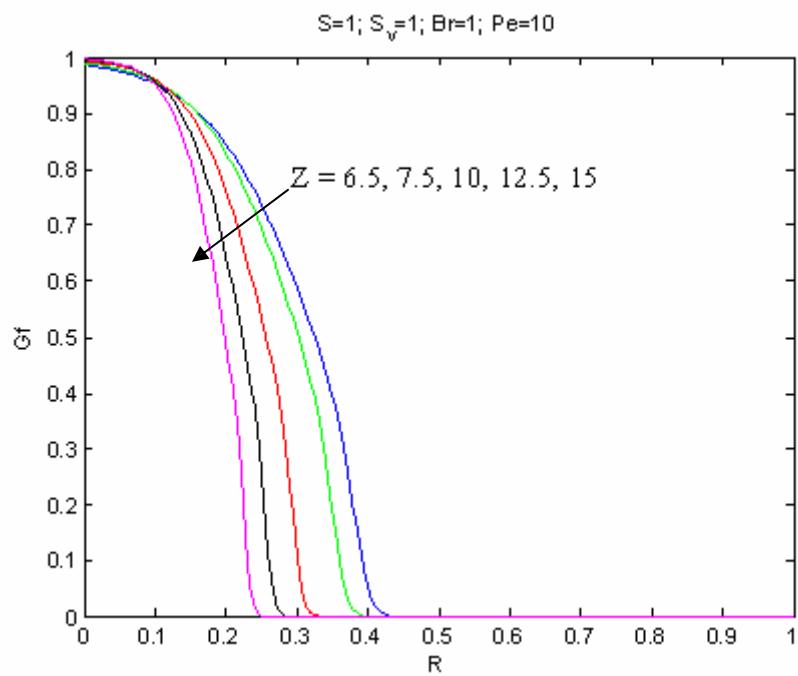


Figure 51. Gr Vs R for  $S=1$ ;  $S_v=1$ ;  $Br=1$ ;  $Pe=10$  and  $Z=6.5, 7.5, 10, 12.5 \& 15$

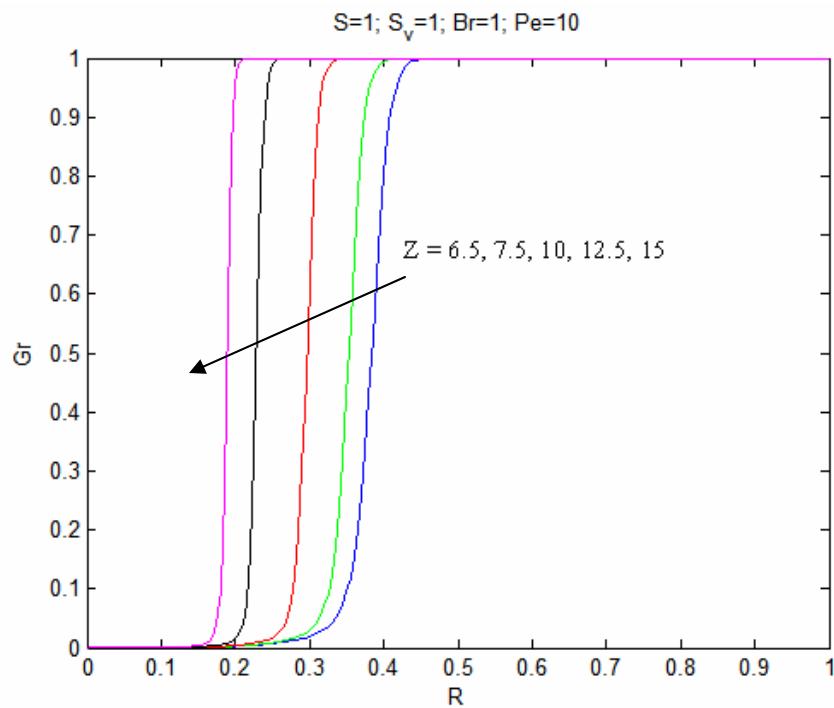


Figure 52. Nf Vs R for  $S=1$ ;  $S_v=1$ ;  $Br=1$ ;  $Pe=10$  and  $Z=6.5, 7.5, 10, 12.5 \& 15$

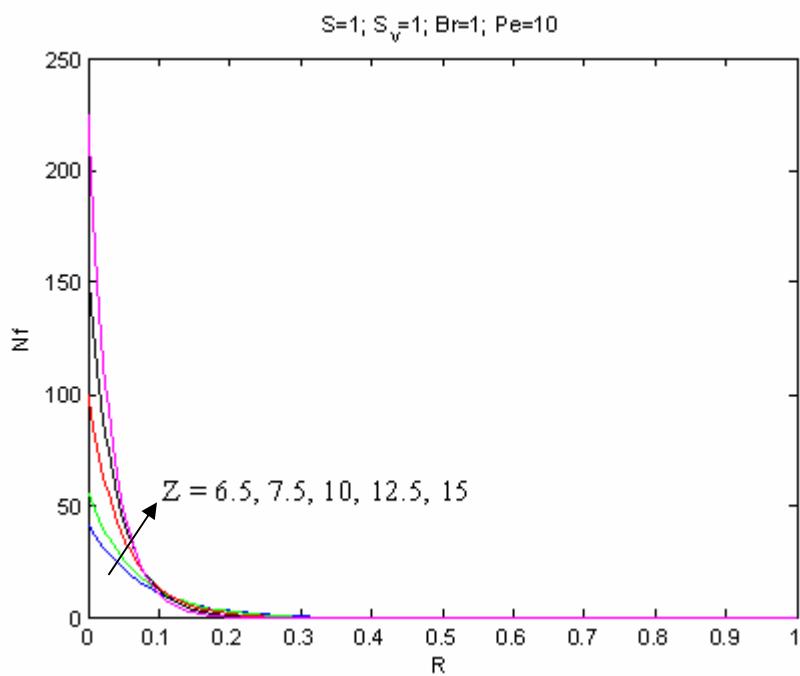


Figure 53.  $N_h$  Vs  $R$  for  $S=1$ ;  $S_v=1$ ;  $Br=1$ ;  $Pe=10$  and  $Z=6.5, 7.5, 10, 12.5 \& 15$

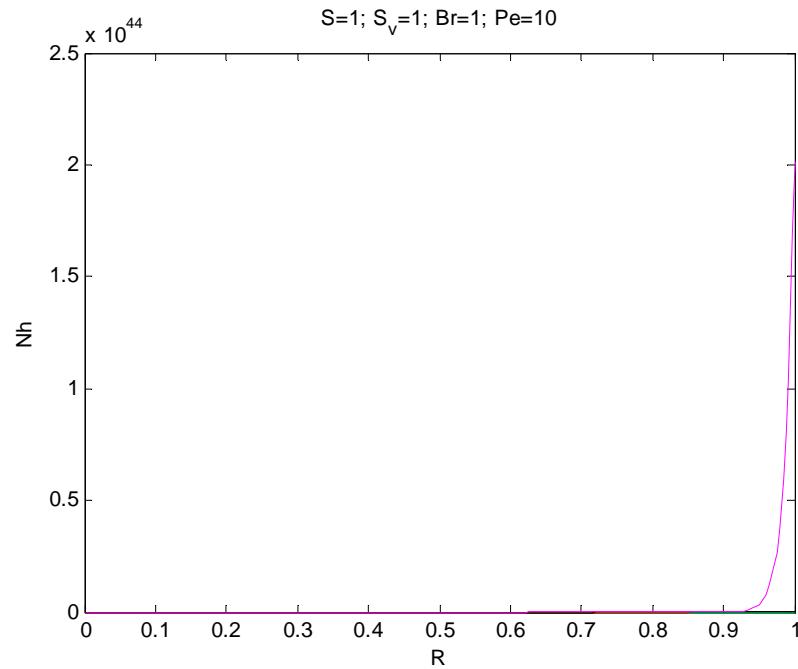


Figure 54.  $N_s$  Vs  $R$  for  $S=1$ ;  $S_v=1$ ;  $Z=1$ ;  $Br=1$  and  $Pe=2, 4, 6, 8 \& 10$

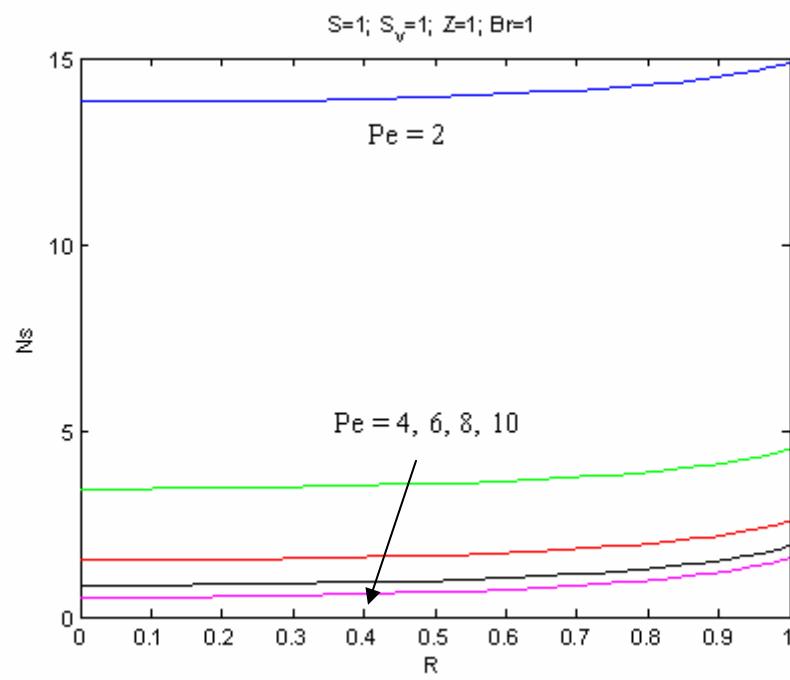


Figure 55. Be Vs R for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

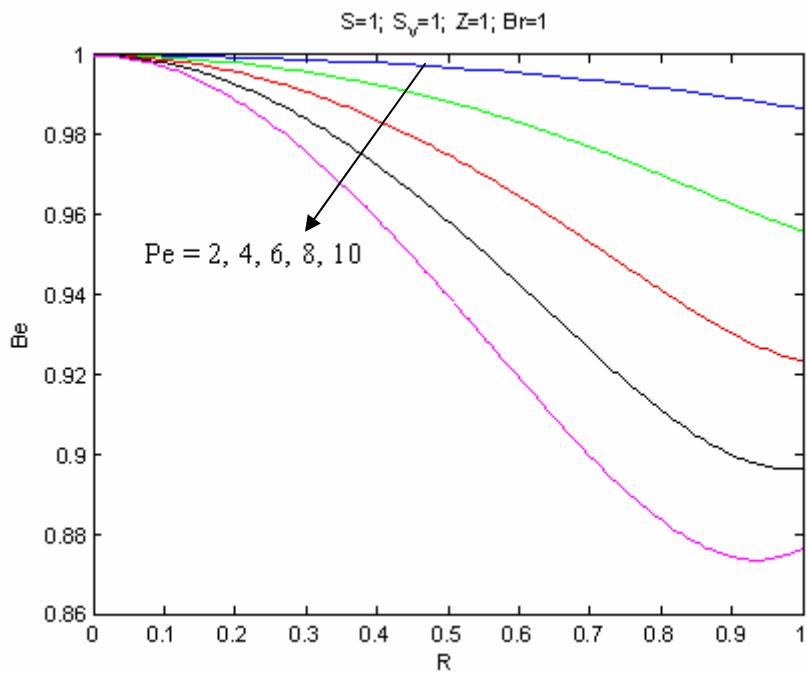


Figure 56.  $\Phi$  Vs R for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

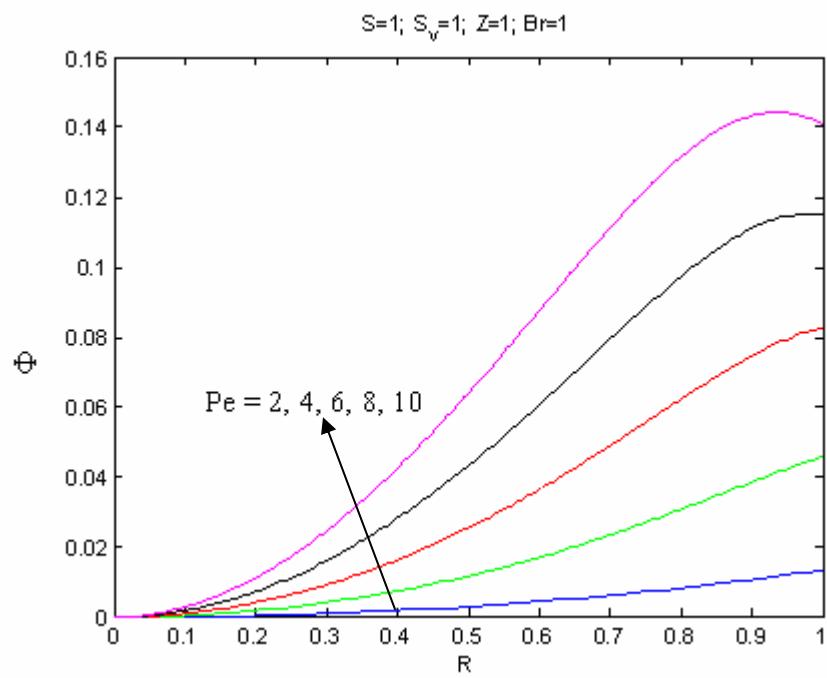


Figure 57. Gf Vs R for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

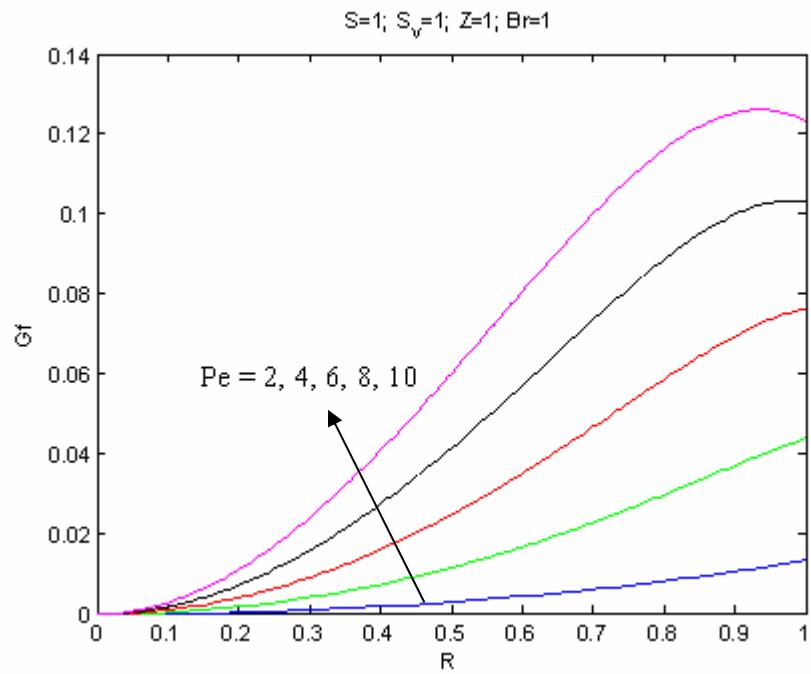


Figure 58. Gr Vs R for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

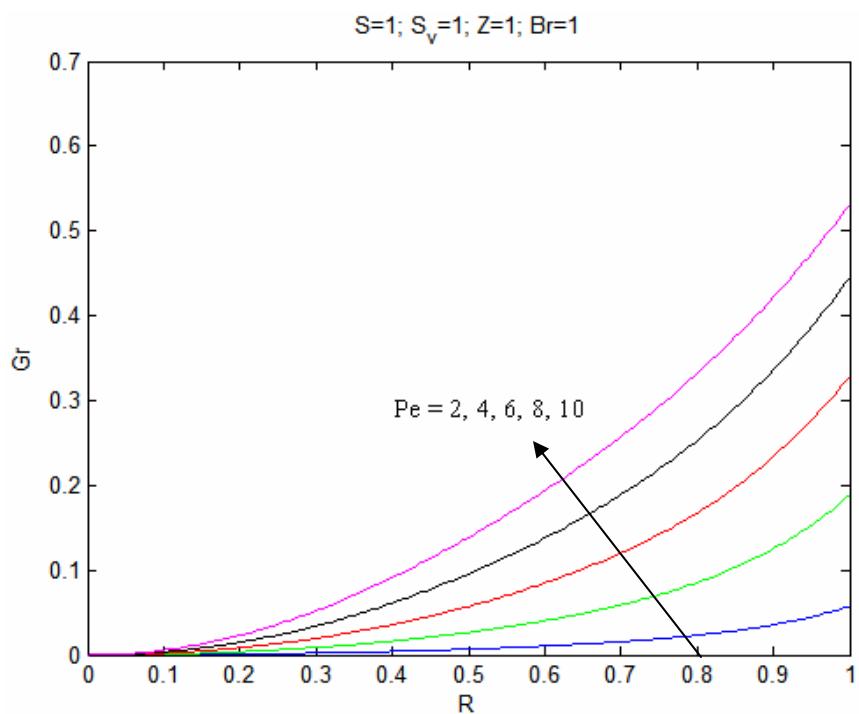


Figure 59. Nc Vs R for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

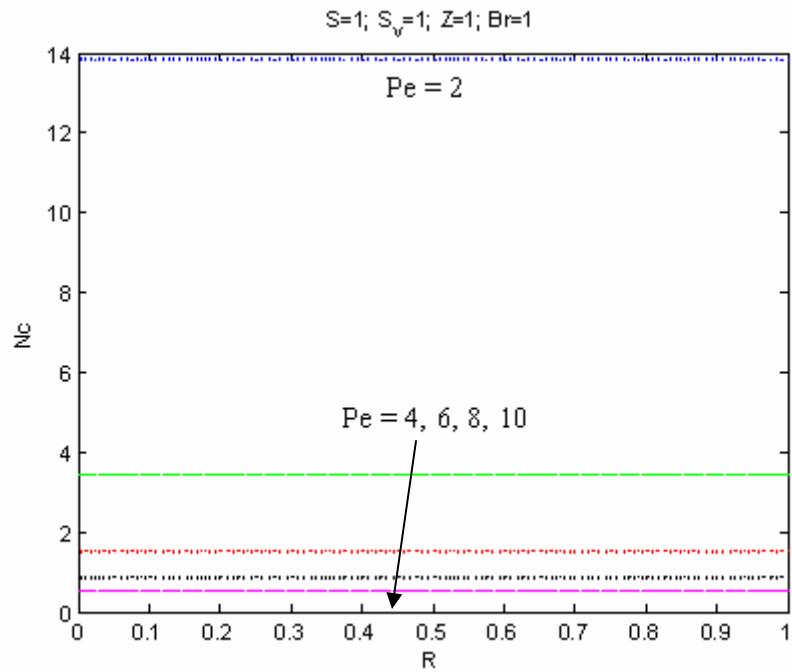


Figure 60. Nh Vs R for S=1; Sv=1; Z=1; Br=1 and Pe=2, 4, 6, 8 & 10

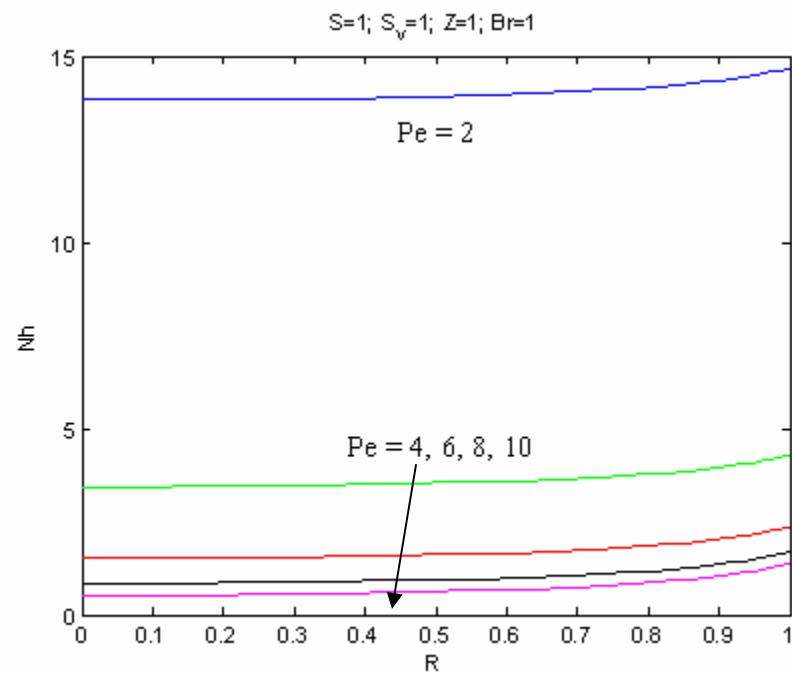


Figure 61. Ns Vs R for Sv=1; Z=1; Br=1; Pe=10 and S=1, 4, 8, 12 & 16

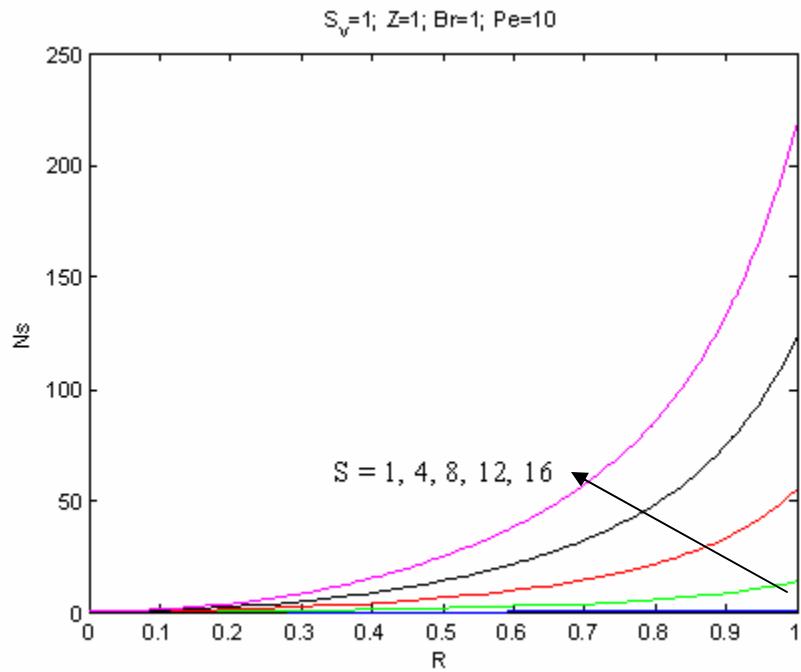


Figure 62. Be Vs R for Sv=1; Z=1; Br=1; Pe=10 and S=1, 4, 8, 12 & 16

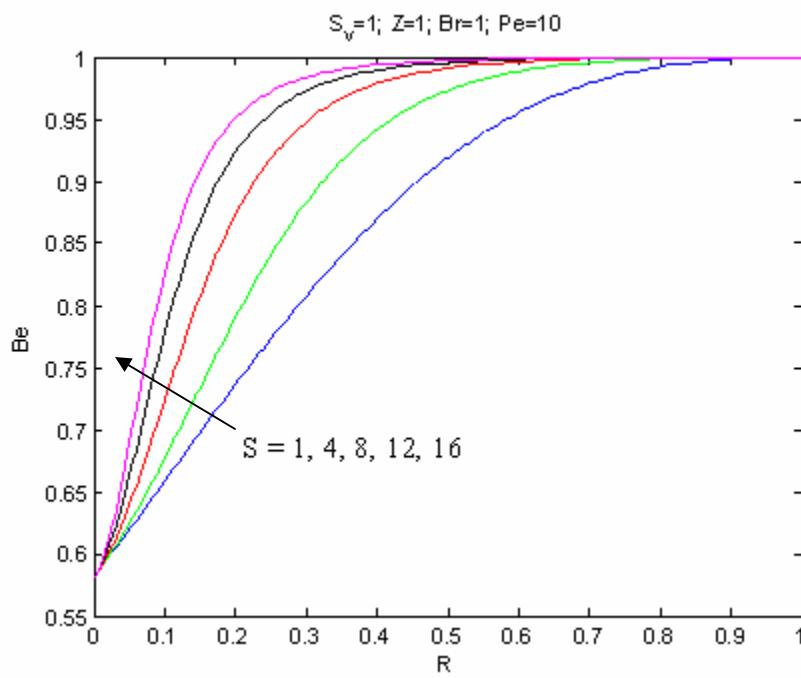


Figure 63.  $\Phi$  Vs R for  $S_v=1$ ;  $Z=1$ ;  $Br=1$ ;  $Pe=10$  and  $S=1, 4, 8, 12 \& 16$

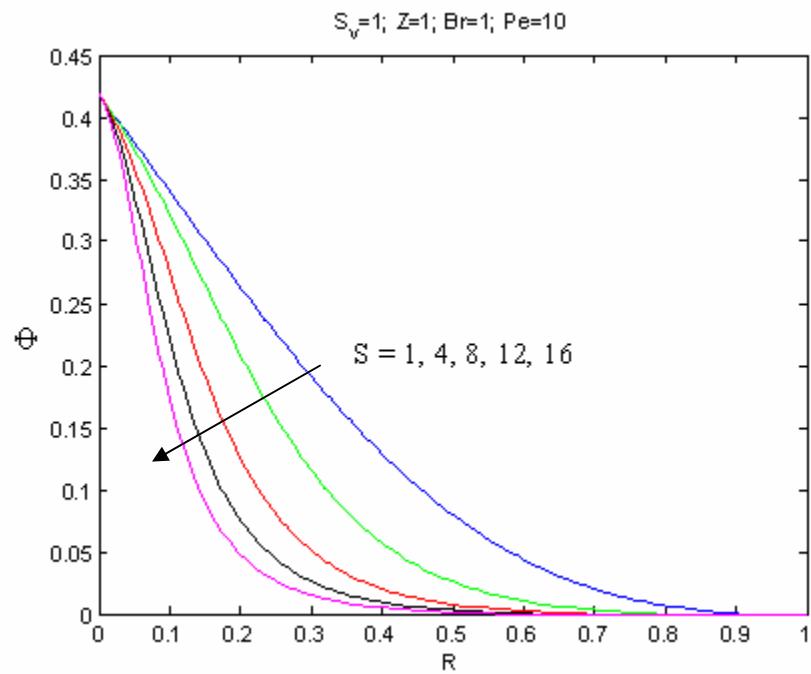


Figure 64.  $G_f$  Vs R for  $S_v=1$ ;  $Z=1$ ;  $Br=1$ ;  $Pe=10$  and  $S=1, 4, 8, 12 \& 16$

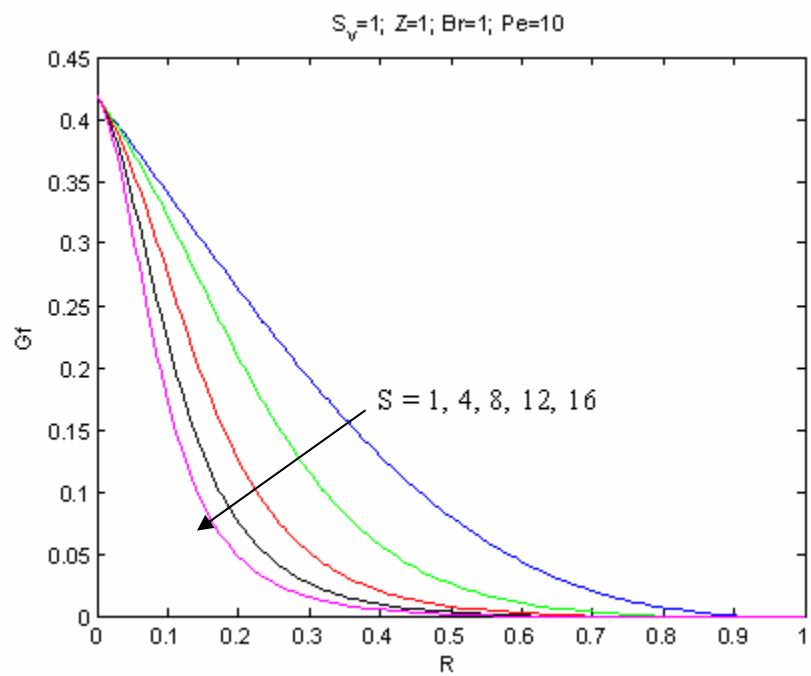


Figure 65. Gr Vs R for  $Sv=1$ ;  $Z=1$ ;  $Br=1$ ;  $Pe=10$  and  $S=1, 4, 8, 12 \& 16$

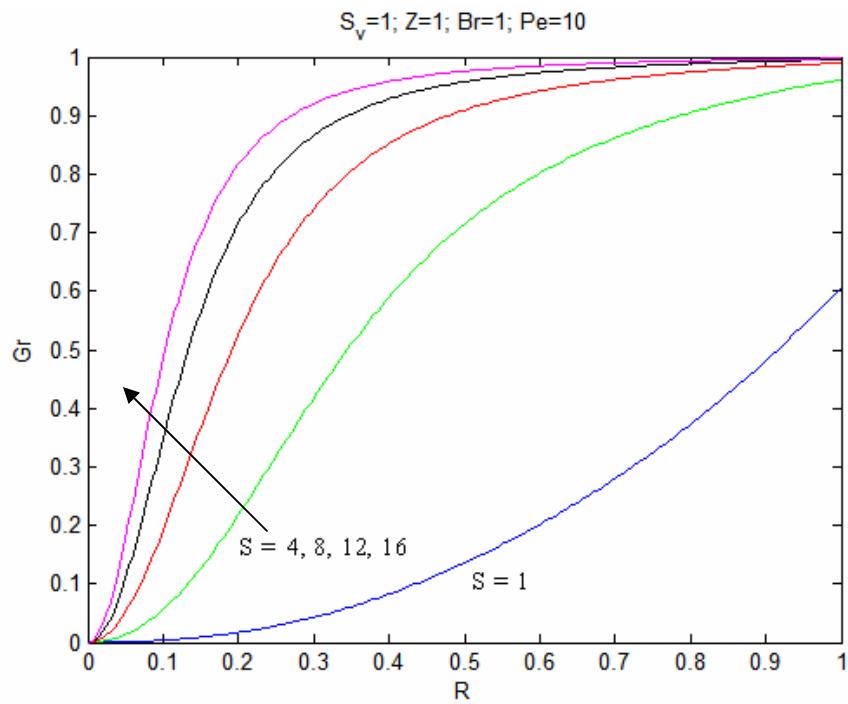


Figure 66. Nf Vs R for  $Sv=1$ ;  $Z=1$ ;  $Br=1$ ;  $Pe=10$  and  $S=1, 4, 8, 12 \& 16$

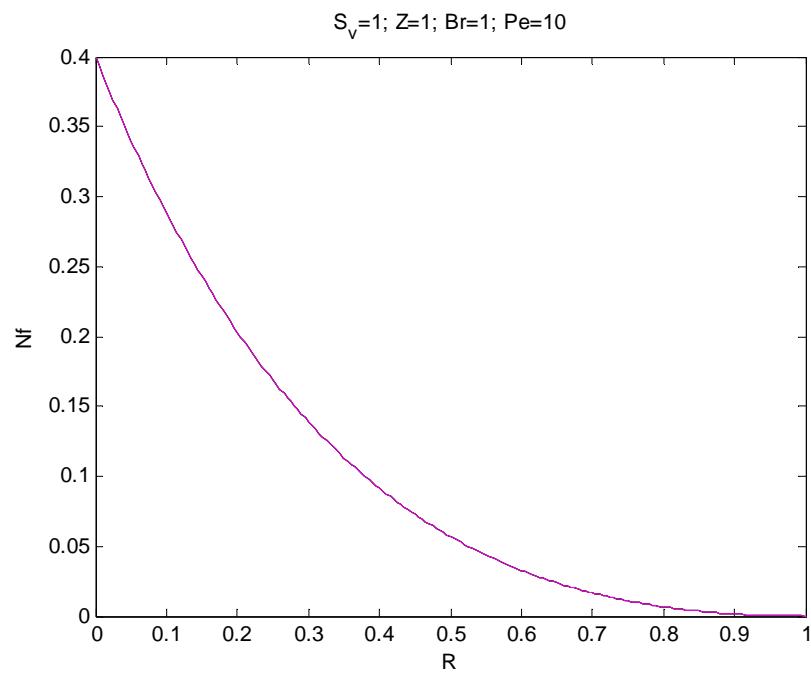


Figure 67. Nh Vs R for Sv=1; Z=1; Br=1; Pe=10 and S=1, 4, 8, 12 & 16

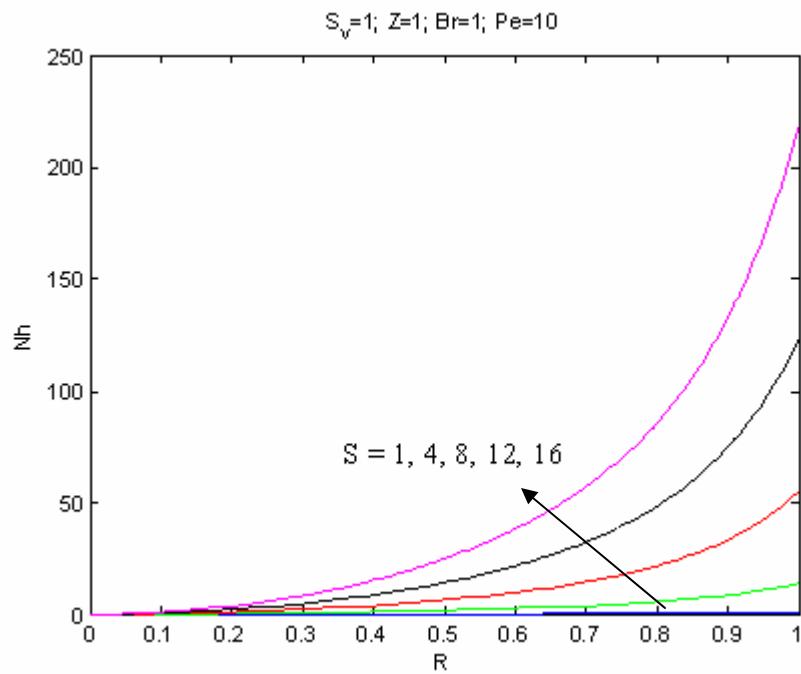


Figure 68. Ns Vs R for S=1; Z=1; Br=1; Pe=10 and Sv=1, 4, 8, 12 & 16

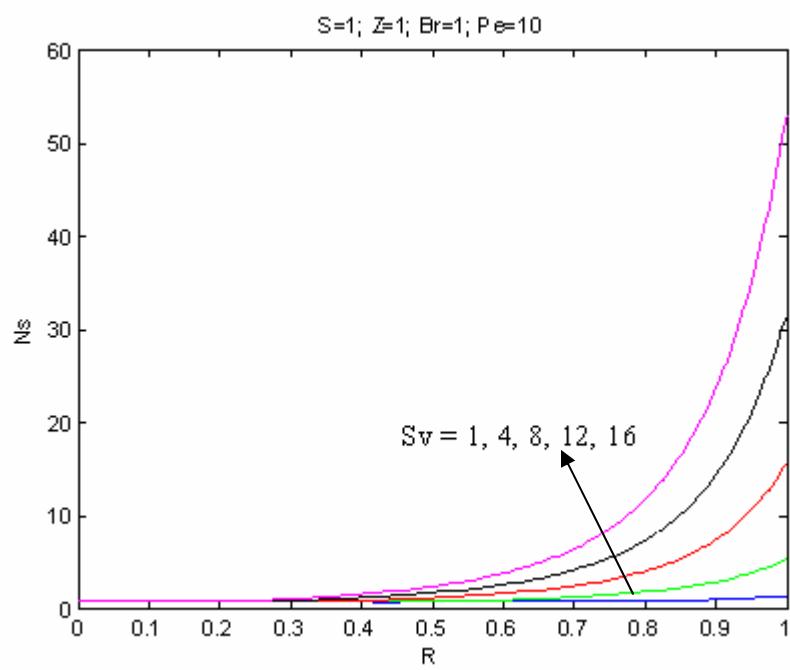


Figure 69. Be Vs R for S=1; Z=1; Br=1; Pe=10 and Sv=1, 4, 8, 12 & 16

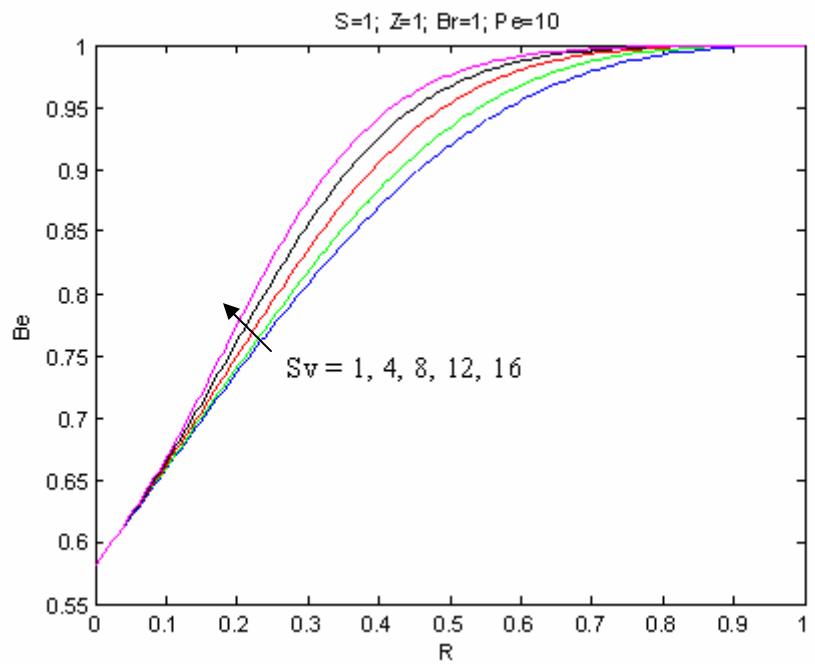


Figure 70.  $\Phi$  Vs R for S=1; Z=1; Br=1; Pe=10 and Sv=1, 4, 8, 12 & 16

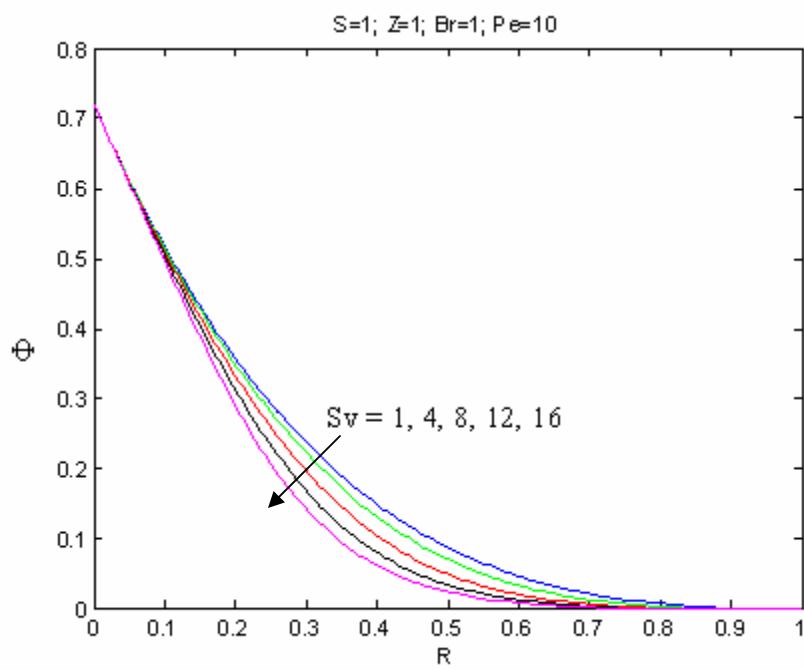


Figure 71. Gf Vs R for S=1; Z=1; Br=1; Pe=10 and Sv=1, 4, 8, 12 & 16

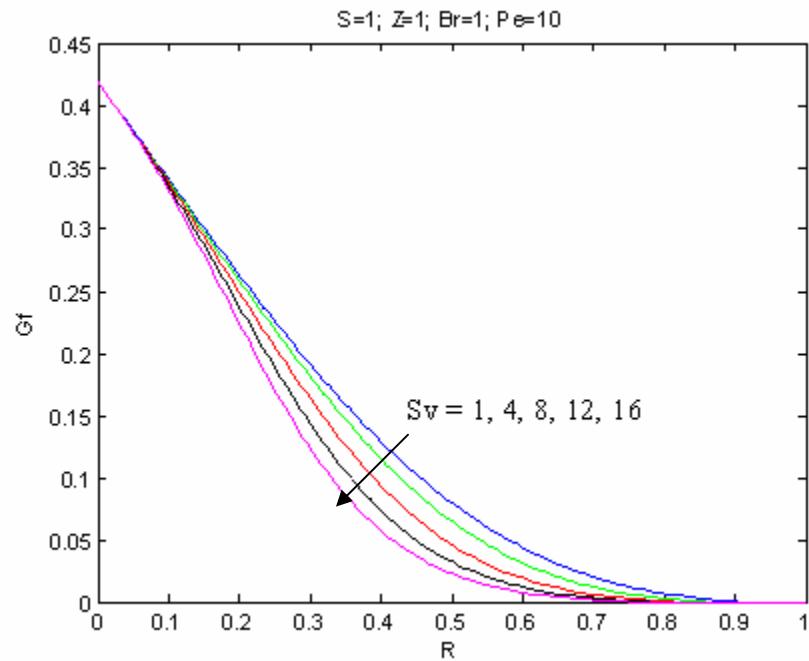


Figure 72. Gr Vs R for S=1; Z=1; Br=1; Pe=10 and Sv=1, 4, 8, 12 & 16

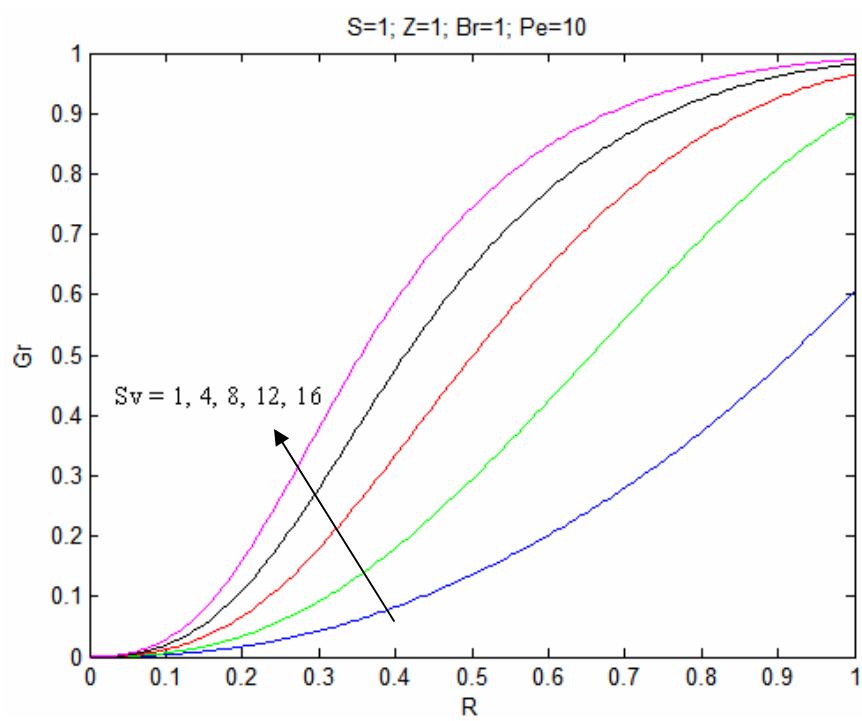


Figure 73. Nf Vs R for S=1; Z=1; Br=1; Pe=10 and Sv=1, 4, 8, 12 & 16

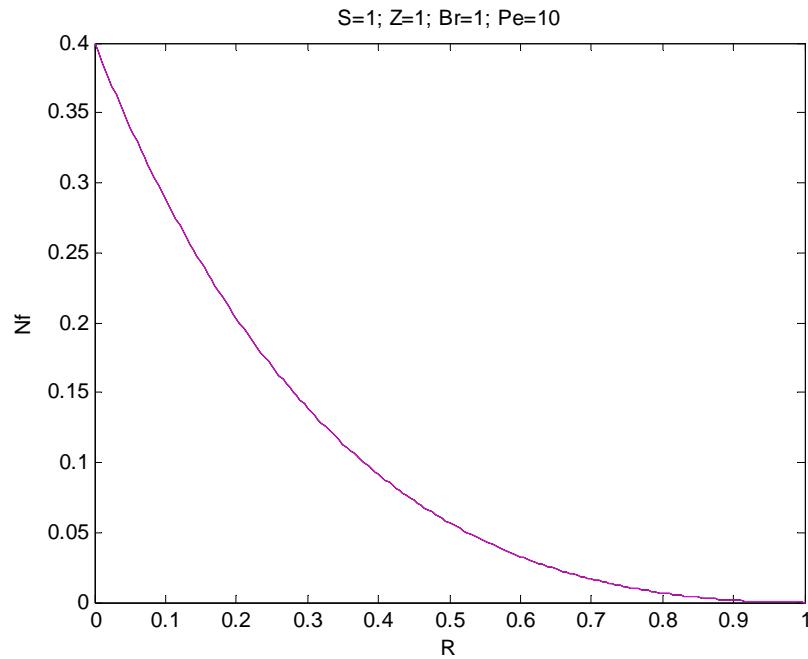
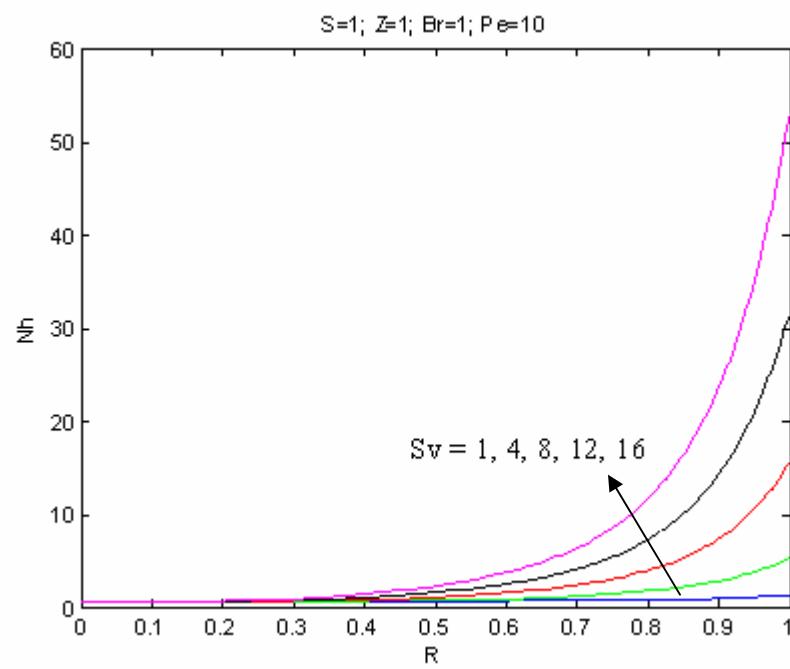


Figure 74. Nh Vs R for S=1; Z=1; Br=1; Pe=10 and Sv=1, 4, 8, 12 & 16



## **MATLAB PROGRAMS**

**1. PROGRAMS FOR  
PARALLEL PLATE MICROCHANNEL**

## 1.1. Distribution of $N_s$ , $Be$ , $\Phi$ , $G_F$ , $G_H$ , $N_F$ and $N_H$ versus $Y$ for a range of

$Br$  and set of  $S$ ,  $S_v$ ,  $Z$  &  $Pe$

```

S=1; S_v=1; Z=1; Pe=10;
% S=5; S_v=0.75; Z=7.5; Pe=2;
% % % % S=2; S_v=1; Z=5; Pe=0.5;
% % % % S=10; S_v=25; Z=20; Pe=5;
% % % % S=20; S_v=2; Z=2.5; Pe=1;
% % % % S=25; S_v=15; Z=10; Pe=2.5;

q=1.86;
s=1;
Dh=250*10^-6;
Y=0:0.005:1;

Nc=[1/Pe^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];

Ny=1 - exp(-2*Z) + exp(-Z - Y.*Z) - (2*S)/exp(2*Z) + 2*exp(-Z - Y.*Z)*S - S^2/exp(2*Z) + exp(-Z - Y.*Z)*S^2 - 2.*Y + Y.^2 + Y.^2/exp(2*Z) - exp(-Z - Y.*Z).*Y.^2 ...
+ (2*S.*Y.^2)/exp(2*Z) - 2*exp(-Z - Y.*Z)*S.*Y.^2 + (S^2.*Y.^2)/exp(2*Z) - exp(-Z - Y.*Z)*S^2.*Y.^2 + 1/(exp(2*Z)*Z^2) + 1./(exp(2.*Y.*Z)*Z^2) ...
- (2*exp(-Z - Y.*Z))/Z^2 + (2*S)/(exp(2*Z)*Z^2) + (2*S)./(exp(2.*Y.*Z)*Z^2) - (4*exp(-Z - Y.*Z)*S)/Z^2 + S^2/(exp(2*Z)*Z^2) + S^2./(exp(2.*Y.*Z)*Z^2) ...
- (2*exp(-Z - Y.*Z)*S^2)/Z^2 + 2/(exp(Z)*Z) - 2./((exp(Y.*Z)*Z) + (2*S)/(exp(Z)*Z) - (2*S)./(exp(Y.*Z)*Z) - (2.*Y)/(exp(Z)*Z) + (2.*Y)/(exp(Y.*Z)*Z) ...
- (2*S.*Y)/(exp(Z)*Z) + (2*S.*Y)/(exp(Y.*Z)*Z) - Z/exp(Z) - (S*Z)/exp(Z) + (Y.*Z)/exp(Z) + (S.*Y.*Z)/exp(Z) + (Y.^2*Z)/exp(Z) + (S.*Y.^2*Z)/exp(Z) - (Y.^3*Z)/exp(Z) ...
- (S.*Y.^3*Z)/exp(Z) + Z^2/(4*exp(2*Z)) + (S*Z^2)/(2*exp(2*Z)) + (S^2*Z^2)/(4*exp(2*Z)) - (Y.^2*Z^2)/(2*exp(2*Z)) - (S.*Y.^2*Z^2)/exp(2*Z) ...
- (S^2.*Y.^2*Z^2)/(2*exp(2*Z)) + (Y.^4*Z^2)/(4*exp(2*Z)) + (S.*Y.^4*Z^2)/(2*exp(2*Z)) + (S^2.*Y.^4*Z^2)/(4*exp(2*Z)) - (7*S*(S_v))/(2*exp(3*Z)) ...
+ (2*S*(S_v))/exp(2*Z) + (S*(S_v))/exp(Z) - (exp(-Z - 2.*Y.*Z)*S*(S_v))/2 - (5*S^2*(S_v))/exp(3*Z) + (2*S^2*(S_v))/exp(2*Z) - (S^2*(S_v))/(2*exp(Z)) ...
- (exp(-Z - 2.*Y.*Z)*S^2*(S_v))/2 - (2*S.*Y.*(S_v))/exp(2*Z) - (3*S.*Y.*(S_v))/exp(Z) + (3*S^2.*Y.*(S_v))/(2*exp(3*Z)) - (2*S^2.*Y.*(S_v))/exp(2*Z) ...
+ (S^2.*Y.*(S_v))/(2*exp(Z)) + (13*S.*Y.^2*(S_v))/(2*exp(3*Z)) - (4*S.*Y.^2*(S_v))/exp(2*Z) + (3*S.*Y.^2*(S_v))/exp(Z) + (exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v))/2 - (3*S.*Y.^3*(S_v))/exp(3*Z) ...
+ (5*S^2.*Y.^2*(S_v))/exp(3*Z) - (2*S^2.*Y.^2*(S_v))/exp(2*Z) + (S^2.*Y.^2*(S_v))/(2*exp(Z)) + (exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v))/2 - (3*S.*Y.^3*(S_v))/exp(3*Z) ...
+ (4*S.*Y.^3*(S_v))/exp(2*Z) - (S.*Y.^3*(S_v))/exp(Z) - (3*S^2.*Y.^3*(S_v))/(2*exp(3*Z)) + (2*S^2.*Y.^3*(S_v))/exp(2*Z) - (S^2.*Y.^3*(S_v))/(2*exp(Z)) ...
+ (3*S*(S_v))/(exp(4*Z)*Z^3) - (4*S*(S_v))/(exp(3*Z)*Z^3) + (S*(S_v))/(exp(2*Z)*Z^3) + (S*(S_v))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S*(S_v))/Z^3 ...
- (4*exp(-Z - 2.*Y.*Z)*S*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S*(S_v))/Z^3 + (8*exp(-2*Z - Y.*Z)*S*(S_v))/Z^3 - (2*exp(-Z - Y.*Z)*S*(S_v))/Z^3 ...
+ (3*S^2*(S_v))/(exp(4*Z)*Z^3) - (4*S^2*(S_v))/(exp(3*Z)*Z^3) + (S^2*(S_v))/(exp(2*Z)*Z^3) + (S^2*(S_v))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v))/Z^3 ...
- (4*exp(-Z - 2.*Y.*Z)*S^2*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S^2*(S_v))/Z^3 + (8*exp(-2*Z - Y.*Z)*S^2*(S_v))/Z^3 - (2*exp(-Z - Y.*Z)*S^2*(S_v))/Z^3 ...
+ (11*S*(S_v))/(exp(3*Z)*Z^2) - (8*S*(S_v))/(exp(2*Z)*Z^2) + (2*S*(S_v))/(exp(Z)*Z^2) - (S*(S_v))./(exp(3.*Y.*Z)*Z^2) - (2*S*(S_v))./(exp(Y.*Z)*Z^2) ...
- (exp(-Z - 2.*Y.*Z)*S*(S_v))/Z^2 - (9*exp(-2*Z - Y.*Z)*S*(S_v))/Z^2 + (8*exp(-Z - Y.*Z)*S*(S_v))/Z^2 + (8*S^2*(S_v))/(exp(3*Z)*Z^2); ...

```

$$\begin{aligned}
& - (4*S^2*(S_v))/(exp(2*Z)*Z^2) + (S^2*(S_v))/(exp(Z)*Z^2) - (S^2*(S_v))./(exp(3.*Y.*Z)*Z^2) - \\
& (S^2*(S_v))./(exp(Y.*Z)*Z^2) - (exp(-Z - 2.*Y.*Z)*S^2*(S_v))/Z^2 \dots \\
& - (6*exp(-2*Z - Y.*Z)*S^2*(S_v))/Z^2 + (4*exp(-Z - Y.*Z)*S^2*(S_v))/Z^2 - \\
& (6*S.*Y.(S_v))/(exp(3*Z)*Z^2) + (8*S.*Y.(S_v))/(exp(2*Z)*Z^2) \dots \\
& - (2*S.*Y.(S_v))/(exp(Z)*Z^2) + (2*S.*Y.(S_v))/(exp(Y.*Z)*Z^2) + (6*exp(-2*Z - Y.*Z)*S.*Y.(S_v))/Z^2 \dots \\
& - (3*S^2.*Y.(S_v))/(exp(3*Z)*Z^2) + (4*S^2.*Y.(S_v))/(exp(2*Z)*Z^2) - \\
& (S^2.*Y.(S_v))/(exp(Z)*Z^2) + (S^2.*Y.(S_v))/(exp(Y.*Z)*Z^2) \dots \\
& + (3*exp(-2*Z - Y.*Z)*S^2.*Y.(S_v))/Z^2 - (4*exp(-Z - Y.*Z)*S^2.*Y.(S_v))/Z^2 + (S*(S_v))/Z + \\
& (2*S*(S_v))/(exp(3*Z)*Z) + (9*S*(S_v))/(exp(2*Z)*Z) \dots \\
& - (4*S*(S_v))/(exp(Z)*Z) + (S*(S_v))./(exp(2.*Y.*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S*(S_v))/Z + (exp(-Z - Y.*Z)*S*(S_v))/Z + (2*S^2*(S_v))/(exp(3*Z)*Z) \dots \\
& + (S^2*(S_v))/(exp(2*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S^2*(S_v))/Z - (exp(-Z - Y.*Z)*S^2*(S_v))/Z - \\
& (2*S.*Y.(S_v))/Z - (13*S.*Y.(S_v))/(exp(2*Z)*Z) \dots \\
& + (8*S.*Y.(S_v))/(exp(Z)*Z) - (S.*Y.(S_v))./(exp(2.*Y.*Z)*Z) - (2*S^2.*Y.(S_v))/(exp(2*Z)*Z) + \\
& (2*exp(-Z - Y.*Z)*S^2.*Y.(S_v))/Z + (S.*Y.^2*(S_v))/Z \dots \\
& + (3*S.*Y.^2*(S_v))/(exp(4*Z)*Z) - (4*S.*Y.^2*(S_v))/(exp(3*Z)*Z) + \\
& (4*S.*Y.^2*(S_v))/(exp(2*Z)*Z) - (4*S.*Y.^2*(S_v))/(exp(Z)*Z) \dots \\
& - (3*exp(-3*Z - Y.*Z)*S.*Y.^2*(S_v))/Z + (4*exp(-2*Z - Y.*Z)*S.*Y.^2*(S_v))/Z - (exp(-Z - Y.*Z)*S.*Y.^2*(S_v))/Z + (3*S^2.*Y.^2*(S_v))/(exp(4*Z)*Z) \dots \\
& - (4*S^2.*Y.^2*(S_v))/(exp(3*Z)*Z) + (S^2.*Y.^2*(S_v))/(exp(2*Z)*Z) - (3*exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v))/Z + (4*exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v))/Z \dots \\
& - (exp(-Z - Y.*Z)*S^2.*Y.^2*(S_v))/Z - (3*S^2*(S_v))/(4*exp(4*Z)) - (7*S^2*(S_v))/(4*exp(2*Z)) - \\
& (3*S^2*Z*(S_v))/(4*exp(4*Z)) - (3*S^2*Z*(S_v))/(4*exp(2*Z)) \dots \\
& + (2*S.*Y.*Z*(S_v))/exp(2*Z) + (S^2.*Y.*Z*(S_v))/exp(2*Z) + (S.*Y.^2*Z*(S_v))/exp(3*Z) + \\
& (3*S.*Y.^2*Z*(S_v))/(2*exp(2*Z)) + (S^2.*Y.^2*Z*(S_v))/exp(3*Z) \dots \\
& + (S^2.*Y.^2*Z*(S_v))/(2*exp(2*Z)) - (2*S.*Y.^3*Z*(S_v))/exp(2*Z) - \\
& (S^2.*Y.^3*Z*(S_v))/exp(2*Z) + (3*S.*Y.^4*Z*(S_v))/(4*exp(4*Z)) - (S.*Y.^4*Z*(S_v))/exp(3*Z) \dots \\
& + (S.*Y.^4*Z*(S_v))/(4*exp(2*Z)) + (3*S^2.*Y.^4*Z*(S_v))/(4*exp(4*Z)) - \\
& (S^2.*Y.^4*Z*(S_v))/exp(3*Z) + (S^2.*Y.^4*Z*(S_v))/(4*exp(2*Z)) + (S^2*Z^2*(S_v))/(2*exp(3*Z)) \dots \\
& + (S^2*Z^2*(S_v))/(2*exp(3*Z)) - (S.*Y.^2*Z^2*(S_v))/exp(3*Z) - (S^2.*Y.^2*Z^2*(S_v))/exp(3*Z) \\
& + (S.*Y.^4*Z^2*(S_v))/(2*exp(3*Z)) \dots \\
& + (S^2.*Y.^4*Z^2*(S_v))/(2*exp(3*Z)) + (9*S^2*(S_v)^2)/(16*exp(6*Z)) - \\
& (23*S^2*(S_v)^2)/(8*exp(4*Z)) + (2*S^2*(S_v)^2)/exp(3*Z) + (S^2*(S_v)^2)/(16*exp(2*Z)) \dots \\
& - (exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v)^2)/2 - exp(-3*Z - Y.*Z)*S^2*(S_v)^2 - \\
& (2*S^2.*Y.(S_v)^2)/exp(3*Z) - (S^2.*Y.(S_v)^2)/exp(2*Z) + (9*S^2.*Y.^2*(S_v)^2)/(8*exp(6*Z)) \dots \\
& - (3*S^2.*Y.^2*(S_v)^2)/(2*exp(5*Z)) + (11*S^2.*Y.^2*(S_v)^2)/(2*exp(4*Z)) \dots \\
& (7*S^2.*Y.^2*(S_v)^2)/(2*exp(3*Z)) + (15*S^2.*Y.^2*(S_v)^2)/(8*exp(2*Z)) \dots \\
& + (exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v)^2)/2 + exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v)^2 - \\
& (3*S^2.*Y.^3*(S_v)^2)/exp(4*Z) + (4*S^2.*Y.^3*(S_v)^2)/exp(3*Z) \dots \\
& - (S^2.*Y.^3*(S_v)^2)/exp(2*Z) + (9*S^2.*Y.^4*(S_v)^2)/(16*exp(6*Z)) - \\
& (3*S^2.*Y.^4*(S_v)^2)/(2*exp(5*Z)) + (11*S^2.*Y.^4*(S_v)^2)/(8*exp(4*Z)) \dots \\
& - (S^2.*Y.^4*(S_v)^2)/(2*exp(3*Z)) + (S^2.*Y.^4*(S_v)^2)/(16*exp(2*Z)) + \\
& (9*S^2*(S_v)^2)/(4*exp(6*Z)*Z^4) - (6*S^2*(S_v)^2)/(exp(5*Z)*Z^4) \dots \\
& + (11*S^2*(S_v)^2)/(2*exp(4*Z)*Z^4) - (2*S^2*(S_v)^2)/(exp(3*Z)*Z^4) + \\
& (S^2*(S_v)^2)/(4*exp(2*Z)*Z^4) + (S^2*(S_v)^2)/(4*exp(2.*Y.*Z)*Z^4) \dots \\
& + (9*exp(-4*Z - 2.*Y.*Z)*S^2*(S_v)^2)/(4*Z^4) - (6*exp(-3*Z - 2.*Y.*Z)*S^2*(S_v)^2)/Z^4 + \\
& (11*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v)^2)/(2*Z^4) \dots \\
& - (2*exp(-Z - 2.*Y.*Z)*S^2*(S_v)^2)/Z^4 - (9*exp(-5*Z - Y.*Z)*S^2*(S_v)^2)/(2*Z^4) + (12*exp(- \\
& 4*Z - Y.*Z)*S^2*(S_v)^2)/Z^4 - (11*exp(-3*Z - Y.*Z)*S^2*(S_v)^2)/Z^4 \dots \\
& + (4*exp(-2*Z - Y.*Z)*S^2*(S_v)^2)/Z^4 - (exp(-Z - Y.*Z)*S^2*(S_v)^2)/(2*Z^4) + \\
& (12*S^2*(S_v)^2)/(exp(5*Z)*Z^3) - (22*S^2*(S_v)^2)/(exp(4*Z)*Z^3) \dots \\
& + (27*S^2*(S_v)^2)/(2*exp(3*Z)*Z^3) - (4*S^2*(S_v)^2)/(exp(2*Z)*Z^3) + \\
& (S^2*(S_v)^2)/(2*exp(Z)*Z^3) - (S^2*(S_v)^2)/(2*exp(3.*Y.*Z)*Z^3) \dots \\
& - (S^2*(S_v)^2)/(2*exp(Y.*Z)*Z^3) - (3*exp(-2*Z - 3.*Y.*Z)*S^2*(S_v)^2)/(2*Z^3) + (2*exp(-Z - 3.*Y.*Z)*S^2*(S_v)^2)/(2*Z^3) \dots
\end{aligned}$$

$$\begin{aligned}
& + (2*\exp(-2*Z - 2.*Y.*Z)*S^2*(S_v)^2)/Z^3 - (\exp(-Z - 2.*Y.*Z)*S^2*(S_v)^2)/(2*Z^3) - (9*\exp(-4*Z \\
& - Y.*Z)*S^2*(S_v)^2)/Z^3 + (18*\exp(-3*Z - Y.*Z)*S^2*(S_v)^2)/Z^3 ... \\
& - (25*\exp(-2*Z - Y.*Z)*S^2*(S_v)^2)/(2*Z^3) + (4*\exp(-Z - Y.*Z)*S^2*(S_v)^2)/Z^3 - \\
& (9*S^2.*Y.(S_v)^2)/(2*\exp(5*Z)*Z^3) + (12*S^2.*Y.(S_v)^2)/(\exp(4*Z)*Z^3) ... \\
& - (11*S^2.*Y.(S_v)^2)/(\exp(3*Z)*Z^3) + (4*S^2.*Y.(S_v)^2)/(\exp(2*Z)*Z^3) - \\
& (S^2.*Y.(S_v)^2)/(2*\exp(Z)*Z^3) + (S^2.*Y.(S_v)^2)/(2*\exp(Y.*Z)*Z^3) ... \\
& + (9*\exp(-4*Z - Y.*Z)*S^2.*Y.(S_v)^2)/(2*Z^3) - (12*\exp(-3*Z - Y.*Z)*S^2.*Y.(S_v)^2)/Z^3 + \\
& (11*\exp(-2*Z - Y.*Z)*S^2.*Y.(S_v)^2)/Z^3 ... \\
& - (4*\exp(-Z - Y.*Z)*S^2.*Y.(S_v)^2)/Z^3 + (S^2*(S_v)^2)/(4*Z^2) + \\
& (9*S^2*(S_v)^2)/(4*\exp(6*Z)*Z^2) - (3*S^2*(S_v)^2)/(\exp(5*Z)*Z^2) + \\
& (19*S^2*(S_v)^2)/(\exp(4*Z)*Z^2) ... \\
& - (19*S^2*(S_v)^2)/(\exp(3*Z)*Z^2) + (35*S^2*(S_v)^2)/(4*\exp(2*Z)*Z^2) - \\
& (2*S^2*(S_v)^2)/(exp(Z)*Z^2) + (S^2*(S_v)^2)/(4*\exp(4*Y.*Z)*Z^2) ... \\
& + (S^2*(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2) + (\exp(-Z - 3.*Y.*Z)*S^2*(S_v)^2)/Z^2 + (5*\exp(-2*Z \\
& - 2.*Y.*Z)*S^2*(S_v)^2)/Z^2 - (2*\exp(-Z - 2.*Y.*Z)*S^2*(S_v)^2)/Z^2 ... \\
& - (9*\exp(-5*Z - Y.*Z)*S^2*(S_v)^2)/(4*Z^2) + (3*\exp(-4*Z - Y.*Z)*S^2*(S_v)^2)/Z^2 + (5*\exp(-3*Z \\
& - Y.*Z)*S^2*(S_v)^2)/Z^2 - (\exp(-2*Z - Y.*Z)*S^2*(S_v)^2)/Z^2 ... \\
& + (\exp(-Z - Y.*Z)*S^2*(S_v)^2)/(4*Z^2) - (S^2.*Y.(S_v)^2)/(2*Z^2) - \\
& (15*S^2.*Y.(S_v)^2)/(4*\exp(4*Z)*Z^2) + (26*S^2.*Y.(S_v)^2)/(\exp(3*Z)*Z^2) ... \\
& - (29*S^2.*Y.(S_v)^2)/(2*\exp(2*Z)*Z^2) + (4*S^2.*Y.(S_v)^2)/(\exp(Z)*Z^2) - \\
& (S^2.*Y.(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2) - (3*\exp(-2*Z - 2.*Y.*Z)*S^2.*Y.(S_v)^2)/(2*Z^2) ... \\
& + (2*\exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v)^2)/Z^2 + (S^2.*Y.^2*(S_v)^2)/(4*Z^2) + \\
& (9*S^2.*Y.^2*(S_v)^2)/(4*\exp(6*Z)*Z^2) - (6*S^2.*Y.^2*(S_v)^2)/(exp(5*Z)*Z^2) ... \\
& + (31*S^2.*Y.^2*(S_v)^2)/(4*\exp(4*Z)*Z^2) - (8*S^2.*Y.^2*(S_v)^2)/(\exp(3*Z)*Z^2) + \\
& (23*S^2.*Y.^2*(S_v)^2)/(4*\exp(2*Z)*Z^2) - (2*S^2.*Y.^2*(S_v)^2)/(exp(Z)*Z^2) ... \\
& - (9*\exp(-5*Z - Y.*Z)*S^2.*Y.^2*(S_v)^2)/(4*Z^2) + (6*\exp(-4*Z - Y.*Z)*S^2.*Y.^2*(S_v)^2)/Z^2 - \\
& (11*\exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v)^2)/(2*Z^2) ... \\
& + (2*\exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v)^2)/Z^2 - (\exp(-Z - Y.*Z)*S^2.*Y.^2*(S_v)^2)/(4*Z^2) + \\
& (9*S^2*(S_v)^2)/(2*\exp(5*Z)*Z) - (S^2*(S_v)^2)/(exp(4*Z)*Z) ... \\
& + (25*S^2*(S_v)^2)/(4*\exp(3*Z)*Z) - (3*S^2*(S_v)^2)/(\exp(2*Z)*Z) + (3*S^2*(S_v)^2)/(4*\exp(Z)*Z) \\
& + (3*\exp(-3*Z - 2.*Y.*Z)*S^2*(S_v)^2)/(4*Z) ... \\
& + (3*\exp(-Z - 2.*Y.*Z)*S^2*(S_v)^2)/(4*Z) + (3*\exp(-4*Z - Y.*Z)*S^2*(S_v)^2)/Z - (2*\exp(-3*Z - \\
& Y.*Z)*S^2*(S_v)^2)/Z + (2*\exp(-2*Z - Y.*Z)*S^2*(S_v)^2)/Z ... \\
& - (9*S^2.*Y.(S_v)^2)/(4*\exp(5*Z)*Z) + (3*S^2.*Y.(S_v)^2)/(exp(4*Z)*Z) - \\
& (11*S^2.*Y.(S_v)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.(S_v)^2)/(exp(2*Z)*Z) ... \\
& - (7*S^2.*Y.(S_v)^2)/(4*\exp(Z)*Z) - (\exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v)^2)/Z - (2*\exp(-2*Z - \\
& Y.*Z)*S^2.*Y.(S_v)^2)/Z + (15*S^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z)*Z) ... \\
& - (13*S^2.*Y.^2*(S_v)^2)/(exp(4*Z)*Z) + (41*S^2.*Y.^2*(S_v)^2)/(4*\exp(3*Z)*Z) - \\
& (6*S^2.*Y.^2*(S_v)^2)/(exp(2*Z)*Z) + (5*S^2.*Y.^2*(S_v)^2)/(4*\exp(Z)*Z) ... \\
& + (3*\exp(-3*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v)^2)/(4*Z) - (\exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v)^2)/Z + \\
& (\exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v)^2)/(4*Z) ... \\
& - (9*S^2.*Y.^3*(S_v)^2)/(4*\exp(5*Z)*Z) + (6*S^2.*Y.^3*(S_v)^2)/(exp(4*Z)*Z) - \\
& (11*S^2.*Y.^3*(S_v)^2)/(2*\exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v)^2)/(\exp(2*Z)*Z) ... \\
& - (S^2.*Y.^3*(S_v)^2)/(4*\exp(Z)*Z) - (3*S^2*Z*(S_v)^2)/(4*\exp(5*Z)) - \\
& (3*S^2*Z*(S_v)^2)/(4*\exp(3*Z)) + (S^2.*Y.*Z*(S_v)^2)/\exp(3*Z) + (S^2.*Y.^2*Z*(S_v)^2)/\exp(4*Z) ... \\
& + (S^2.*Y.^2*Z*(S_v)^2)/(2*\exp(3*Z)) - (S^2.*Y.^3*Z*(S_v)^2)/\exp(3*Z) + \\
& (3*S^2.*Y.^4*Z*(S_v)^2)/(4*\exp(5*Z)) - (S^2.*Y.^4*Z*(S_v)^2)/\exp(4*Z) ... \\
& + (S^2.*Y.^4*Z*(S_v)^2)/(4*\exp(3*Z)) + (S^2*Z^2*(S_v)^2)/(4*\exp(4*Z)) - \\
& (S^2.*Y.^2*Z^2*(S_v)^2)/(2*\exp(4*Z)) + (S^2.*Y.^4*Z^2*(S_v)^2)/(4*\exp(4*Z));
\end{aligned}$$

Br1=0.2;

Nf1=Br1\*[(Z^2).\*exp(-2.\*Y.\*Z)+(Z^2).\*exp(-2\*Z)-2\*Z^2.\*exp(-Z-Y.\*Z)];

Ns1=Nf1+Nc+Ny;

Phi1=Nf1./[Nc+Ny];

Be1=1./[1+Phi1];

```

Gf1=Nf1./Ns1;
Gh1=[Nc+Ny]./Ns1;

Br2=0.4;
Nf2=Br2*[(Z^2).*exp(-2.*Y.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-Y.*Z)];
Ns2=Nf2+Nc+Ny;
Phi2=Nf2./[Nc+Ny];
Be2=1./[1+Phi2];
Gf2=Nf2./Ns2;
Gh2=[Nc+Ny]./Ns2;

Br3=0.6;
Nf3=Br3*[(Z^2).*exp(-2.*Y.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-Y.*Z)];
Ns3=Nf3+Nc+Ny;
Phi3=Nf3./[Nc+Ny];
Be3=1./[1+Phi3];
Gf3=Nf3./Ns3;
Gh3=[Nc+Ny]./Ns3;

Br4=0.8;
Nf4=Br4*[(Z^2).*exp(-2.*Y.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-Y.*Z)];
Ns4=Nf4+Nc+Ny;
Phi4=Nf4./[Nc+Ny];
Be4=1./[1+Phi4];
Gf4=Nf4./Ns4;
Gh4=[Nc+Ny]./Ns4;

Br5=1;
Nf5=Br5*[(Z^2).*exp(-2.*Y.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-Y.*Z)];
Ns5=Nf5+Nc+Ny;
Phi5=Nf5./[Nc+Ny];
Be5=1./[1+Phi5];
Gf5=Nf5./Ns5;
Gh5=[Nc+Ny]./Ns5;

Nh=Nc+Ny;

plot(Y,Ns1,'b',Y,Ns2,'g',Y,Ns3,'r',Y,Ns4,'k',Y,Ns5,'m')
% plot(Y,Be1,'b',Y,Be2,'g',Y,Be3,'r',Y,Be4,'k',Y,Be5,'m')
% plot(Y,Phi1,'b',Y,Phi2,'g',Y,Phi3,'r',Y,Phi4,'k',Y,Phi5,'m')
% plot(Y,Gf1,'b',Y,Gf2,'g',Y,Gf3,'r',Y,Gf4,'k',Y,Gf5,'m')
% plot(Y,Gh1,'b',Y,Gh2,'g',Y,Gh3,'r',Y,Gh4,'k',Y,Gh5,'m')
% plot(Y,Nf1,'b',Y,Nf2,'g',Y,Nf3,'r',Y,Nf4,'k',Y,Nf5,'m')
% plot(Y,Nh)

PLOTOOLS ON

```

## 1.2. Distribution of $N_s$ , $Be$ , $\Phi$ , $G_F$ , $G_H$ , $N_F$ and $N_H$ versus $Y$ for a range of

$Z$  and set of  $S$ ,  $S_v$ ,  $Br$  &  $Pe$

```
S=1; S_v=1; Br=1; Pe=10;
% S=5; S_v=0.75; Br=0.5; Pe=2;
% % % % S=2; S_v=1; Br=0.8; Pe=0.5;
% % % % S=7.5; S_v=15; Br=0.6; Pe=2.5;
% % % % S=10; S_v=5; Br=0.9; Pe=5;
% % % % S=20; S_v=5; Br=0.2; Pe=0.5;
```

$q=1.86;$

```
s=1;
Dh=250*10^-6;
Y=0:0.005:1;
```

$Nc=[1/Pe^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];$

$Z1=6.5;$

```
Nf1=Br*[(Z1^2).*exp(-2.*Y.*Z1)+(Z1^2)*exp(-2*Z1)-2*Z1^2.*exp(-Z1-Y.*Z1)];
Ny1=1 - exp(-2*Z1) + exp(-Z1 - Y.*Z1) - (2*S)/exp(2*Z1) + 2*exp(-Z1 - Y.*Z1)*S - S^2/exp(2*Z1) +
exp(-Z1 - Y.*Z1)*S^2 - 2.*Y + Y.^2 + Y.^2/exp(2*Z1) - exp(-Z1 - Y.*Z1).*Y.^2 ...
+ (2*S.*Y.^2)/exp(2*Z1) - 2*exp(-Z1 - Y.*Z1)*S.*Y.^2 + (S^2.*Y.^2)/exp(2*Z1) - exp(-Z1 -
Y.*Z1)*S^2.*Y.^2 + 1/(exp(2*Z1)*Z1^2) + 1./((exp(2.*Y.*Z1)*Z1^2) ...
- (2*exp(-Z1 - Y.*Z1))/Z1^2 + (2*S)/(exp(2*Z1)*Z1^2) + (2*S)./(exp(2.*Y.*Z1)*Z1^2) - (4*exp(-Z1 -
Y.*Z1)*S)/Z1^2 + S^2/(exp(2*Z1)*Z1^2) + S^2./((exp(2.*Y.*Z1)*Z1^2) ...
- (2*exp(-Z1 - Y.*Z1)*S^2)/Z1^2 + 2/(exp(Z1)*Z1) - 2./((exp(Y.*Z1)*Z1) + (2*S)/(exp(Z1)*Z1) -
(2*S)./(exp(Y.*Z1)*Z1) - (2.*Y)/(exp(Z1)*Z1) ...
- (2*S.*Y)/(exp(Z1)*Z1) + (2*S.*Y)/(exp(Y.*Z1)*Z1) - Z1/exp(Z1) - (S*Z1)/exp(Z1) +
(Y.*Z1)/exp(Z1) + (S.*Y.*Z1)/exp(Z1) + (Y.^2*Z1)/exp(Z1) + (S.*Y.^2*Z1)/exp(Z1) - (Y.^3*Z1)/exp(Z1)
...
- (S.*Y.^3*Z1)/exp(Z1) + Z1^2/(4*exp(2*Z1)) + (S*Z1^2)/(2*exp(2*Z1)) + (S^2*Z1^2)/(4*exp(2*Z1))
- (Y.^2*Z1^2)/(2*exp(2*Z1)) - (S.*Y.^2*Z1^2)/exp(2*Z1) ...
- (S^2.*Y.^2*Z1^2)/(2*exp(2*Z1)) + (Y.^4*Z1^2)/(4*exp(2*Z1)) + (S.*Y.^4*Z1^2)/(2*exp(2*Z1)) +
(S^2.*Y.^4*Z1^2)/(4*exp(2*Z1)) - (7*S*(S_v))/(2*exp(3*Z1)) ...
+ (2*S*(S_v))/exp(2*Z1) + (S*(S_v))/exp(Z1) - (exp(-Z1 - 2.*Y.*Z1)*S*(S_v))/2 -
(5*S^2*(S_v))/exp(3*Z1) + (2*S^2*(S_v))/exp(2*Z1) - (S^2*(S_v))/(2*exp(Z1)) ...
- (exp(-Z1 - 2.*Y.*Z1)*S^2*(S_v))/2 - (2*S.*Y.(S_v))/exp(2*Z1) - (3*S.*Y.(S_v))/exp(Z1) +
(3*S^2.*Y.(S_v))/(2*exp(3*Z1)) - (2*S^2.*Y.(S_v))/exp(2*Z1) ...
+ (S^2.*Y.(S_v))/(2*exp(Z1)) + (13*S.*Y.^2*(S_v))/(2*exp(3*Z1)) - (4*S.*Y.^2*(S_v))/exp(2*Z1) +
(3*S.*Y.^2*(S_v))/exp(Z1) + (exp(-Z1 - 2.*Y.*Z1)*S.*Y.^2*(S_v))/2 ...
+ (5*S^2.*Y.^2*(S_v))/exp(3*Z1) - (2*S^2.*Y.^2*(S_v))/exp(2*Z1) + (S^2.*Y.^2*(S_v))/(2*exp(Z1)) +
(exp(-Z1 - 2.*Y.*Z1)*S^2.*Y.^2*(S_v))/2 - (3*S.*Y.^3*(S_v))/exp(3*Z1) ...
+ (4*S.*Y.^3*(S_v))/exp(2*Z1) - (S.*Y.^3*(S_v))/exp(Z1) - (3*S^2.*Y.^3*(S_v))/(2*exp(3*Z1)) +
(2*S^2.*Y.^3*(S_v))/exp(2*Z1) - (S^2.*Y.^3*(S_v))/(2*exp(Z1)) ...
+ (3*S*(S_v))/(exp(4*Z1)*Z1^3) - (4*S*(S_v))/(exp(3*Z1)*Z1^3) + (S*(S_v))/(exp(2*Z1)*Z1^3) +
(S*(S_v))./(exp(2.*Y.*Z1)*Z1^3) + (3*exp(-2*Z1 - 2.*Y.*Z1)*S*(S_v))/Z1^3 ...
- (4*exp(-Z1 - 2.*Y.*Z1)*S*(S_v))/Z1^3 - (6*exp(-3*Z1 - Y.*Z1)*S*(S_v))/Z1^3 + (8*exp(-2*Z1 -
Y.*Z1)*S*(S_v))/Z1^3 - (2*exp(-Z1 - Y.*Z1)*S*(S_v))/Z1^3 ...
```

$$\begin{aligned}
& + \frac{(3*S^2*(S_v))/(exp(4*Z1)*Z1^3)}{(S^2*(S_v))/(exp(2*Z1)*Z1^3)} - \frac{(4*S^2*(S_v))/(exp(3*Z1)*Z1^3)}{(S^2*(S_v))/(exp(2*Y.*Z1)*Z1^3)} + \frac{(3*exp(-2*Z1) - 2.*Y.*Z1)*S^2*(S_v))/Z1^3}{...} \\
& - (4*exp(-Z1 - 2.*Y.*Z1)*S^2*(S_v))/Z1^3 - (6*exp(-3*Z1 - Y.*Z1)*S^2*(S_v))/Z1^3 + (8*exp(-2*Z1 - Y.*Z1)*S^2*(S_v))/Z1^3 - (2*exp(-Z1 - Y.*Z1)*S^2*(S_v))/Z1^3 \\
& + (11*S*(S_v))/(exp(3*Z1)*Z1^2) - (8*S*(S_v))/(exp(2*Z1)*Z1^2) + (2*S*(S_v))/(exp(Z1)*Z1^2) - (S*(S_v))/(exp(3.*Y.*Z1)*Z1^2) - (2*S*(S_v))/(exp(Y.*Z1)*Z1^2) ... \\
& - (exp(-Z1 - 2.*Y.*Z1)*S*(S_v))/Z1^2 - (9*exp(-2*Z1 - Y.*Z1)*S*(S_v))/Z1^2 + (8*exp(-Z1 - Y.*Z1)*S*(S_v))/Z1^2 + (8*S^2*(S_v))/(exp(3*Z1)*Z1^2); ... \\
& - (4*S^2*(S_v))/(exp(2*Z1)*Z1^2) + (S^2*(S_v))/(exp(Z1)*Z1^2) - (exp(-Z1 - 2.*Y.*Z1)*S^2*(S_v))/Z1^2 ... \\
& (S^2*(S_v))/(exp(3.*Y.*Z1)*Z1^2) - (S^2*(S_v))/(exp(Y.*Z1)*Z1^2) - (exp(-Z1 - 2.*Y.*Z1)*S^2*(S_v))/Z1^2 ... \\
& - (6*exp(-2*Z1 - Y.*Z1)*S^2*(S_v))/Z1^2 + (4*exp(-Z1 - Y.*Z1)*S^2*(S_v))/Z1^2 - (6*S.*Y.(S_v))/(exp(3*Z1)*Z1^2) + (8*S.*Y.(S_v))/(exp(2*Z1)*Z1^2) ... \\
& - (2*S.*Y.(S_v))/(exp(Z1)*Z1^2) + (2*S.*Y.(S_v))/(exp(Y.*Z1)*Z1^2) + (6*exp(-2*Z1 - Y.*Z1)*S.*Y.(S_v))/Z1^2 ... \\
& - (3*S^2.*Y.(S_v))/(exp(3*Z1)*Z1^2) + (4*S^2.*Y.(S_v))/(exp(2*Z1)*Z1^2) - (S^2.*Y.(S_v))/(exp(Z1)*Z1^2) + (S^2.*Y.(S_v))/(exp(Y.*Z1)*Z1^2) ... \\
& + (3*exp(-2*Z1 - Y.*Z1)*S^2.*Y.(S_v))/Z1^2 - (4*exp(-Z1 - Y.*Z1)*S^2.*Y.(S_v))/Z1^2 + (S*(S_v))/Z1 + (2*S*(S_v))/(exp(3*Z1)*Z1) + (9*S*(S_v))/(exp(2*Z1)*Z1) ... \\
& - (4*S*(S_v))/(exp(Z1)*Z1) + (S*(S_v))/(exp(2.*Y.*Z1)*Z1) - (2*exp(-2*Z1 - Y.*Z1)*S*(S_v))/Z1 + (exp(-Z1 - Y.*Z1)*S*(S_v))/Z1 + (2*S^2*(S_v))/(exp(3*Z1)*Z1) ... \\
& + (S^2*(S_v))/(exp(2*Z1)*Z1) - (2*exp(-2*Z1 - Y.*Z1)*S^2*(S_v))/Z1 - (exp(-Z1 - Y.*Z1)*S^2*(S_v))/Z1 - (2*S.*Y.(S_v))/(exp(2*Z1)*Z1) ... \\
& + (8*S.*Y.(S_v))/(exp(Z1)*Z1) - (S.*Y.(S_v))/(exp(2.*Y.*Z1)*Z1) - (2*S^2.*Y.(S_v))/(exp(2*Z1)*Z1) + (S.*Y.^2*(S_v))/Z1 ... \\
& + (3*S.*Y.^2*(S_v))/(exp(4*Z1)*Z1) - (4*S.*Y.^2*(S_v))/(exp(3*Z1)*Z1) + (4*S.*Y.^2*(S_v))/(exp(2*Z1)*Z1) ... \\
& (4*S.*Y.^2*(S_v))/(exp(2*Z1)*Z1) - (4*S.*Y.^2*(S_v))/(exp(Z1)*Z1) ... \\
& - (3*exp(-3*Z1 - Y.*Z1)*S.*Y.^2*(S_v))/Z1 + (4*exp(-2*Z1 - Y.*Z1)*S.*Y.^2*(S_v))/Z1 - (exp(-Z1 - Y.*Z1)*S.*Y.^2*(S_v))/Z1 + (3*S^2.*Y.^2*(S_v))/(exp(4*Z1)*Z1) ... \\
& - (4*S^2.*Y.^2*(S_v))/(exp(3*Z1)*Z1) + (S^2.*Y.^2*(S_v))/(exp(2*Z1)*Z1) - (3*exp(-3*Z1 - Y.*Z1)*S^2.*Y.^2*(S_v))/Z1 ... \\
& - (exp(-Z1 - Y.*Z1)*S^2.*Y.^2*(S_v))/Z1 - (3*S^2*Z1*(S_v))/(4*exp(4*Z1)) - (3*S^2*Z1*(S_v))/(4*exp(2*Z1)) ... \\
& + (2*S.*Y.*Z1*(S_v))/(exp(2*Z1)) + (S^2.*Y.*Z1*(S_v))/(exp(2*Z1)) + (S.*Y.^2*Z1*(S_v))/(exp(3*Z1) + (3*S.*Y.^2*Z1*(S_v))/(2*exp(2*Z1)) + (S^2.*Y.^2*Z1*(S_v))/(exp(3*Z1) ... \\
& + (S^2.*Y.^2*Z1*(S_v))/(2*exp(2*Z1)) - (2*S.*Y.^2*Z1*(S_v))/(exp(2*Z1)) - (S.*Y.^3*Z1*(S_v))/(4*exp(4*Z1)) ... \\
& (S.^Y.^4*Z1*(S_v))/(exp(2*Z1)) + (3*S.*Y.^4*Z1*(S_v))/(4*exp(4*Z1)) ... \\
& + (S.*Y.^4*Z1*(S_v))/(4*exp(2*Z1)) + (3*S^2.*Y.^4*Z1*(S_v))/(4*exp(4*Z1)) ... \\
& (S^2*Z1^2*(S_v))/(2*exp(3*Z1)) ... \\
& + (S^2*Z1^2*(S_v))/(2*exp(3*Z1)) - (S.*Y.^2*Z1^2*(S_v))/(exp(3*Z1)) ... \\
& (S^2.*Y.^2*Z1^2*(S_v))/(exp(3*Z1)) + (S.*Y.^4*Z1^2*(S_v))/(2*exp(3*Z1)) ... \\
& + (S^2.*Y.^4*Z1^2*(S_v))/(2*exp(3*Z1)) + (9*S^2*(S_v)^2)/(16*exp(6*Z1)) ... \\
& (23*S^2*(S_v)^2)/(8*exp(4*Z1)) + (2*S^2*(S_v)^2)/(exp(3*Z1)) + (S^2*(S_v)^2)/(16*exp(2*Z1)) ... \\
& - (exp(-2*Z1 - 2.*Y.*Z1)*S^2*(S_v)^2)/2 - exp(-3*Z1 - Y.*Z1)*S^2*(S_v)^2 - (2*S^2.*Y.(S_v)^2)/(exp(3*Z1) - (S^2.*Y.(S_v)^2)/(exp(2*Z1) + (9*S^2.*Y.^2*(S_v)^2)/(8*exp(6*Z1))) ... \\
& - (3*S^2.*Y.^2*(S_v)^2)/(2*exp(5*Z1)) + (11*S^2.*Y.^2*(S_v)^2)/(2*exp(4*Z1)) - (7*S^2.*Y.^2*(S_v)^2)/(2*exp(3*Z1)) + (15*S^2.*Y.^2*(S_v)^2)/(8*exp(2*Z1)) ... \\
& + (exp(-2*Z1 - 2.*Y.*Z1)*S^2.*Y.^2*(S_v)^2)/2 + exp(-3*Z1 - Y.*Z1)*S^2.*Y.^2*(S_v)^2 - (3*S^2.*Y.^3*(S_v)^2)/(exp(4*Z1) + (4*S^2.*Y.^3*(S_v)^2)/(exp(3*Z1) ... \\
& - (S^2.*Y.^3*(S_v)^2)/(exp(2*Z1)) + (9*S^2.*Y.^4*(S_v)^2)/(16*exp(6*Z1)) ... \\
& (3*S^2.*Y.^4*(S_v)^2)/(2*exp(5*Z1)) + (11*S^2.*Y.^4*(S_v)^2)/(8*exp(4*Z1)) ...
\end{aligned}$$

$$\begin{aligned}
& - \frac{(S^2 \cdot Y^4 \cdot (S_v)^2) / (2 \cdot \exp(3 \cdot Z1))}{(9 \cdot S^2 \cdot (S_v)^2) / (4 \cdot \exp(6 \cdot Z1) \cdot Z1^4)} + \frac{(S^2 \cdot Y^4 \cdot (S_v)^2) / (16 \cdot \exp(2 \cdot Z1))}{(6 \cdot S^2 \cdot (S_v)^2) / (\exp(5 \cdot Z1) \cdot Z1^4)} + \\
& + \frac{(11 \cdot S^2 \cdot (S_v)^2) / (2 \cdot \exp(4 \cdot Z1) \cdot Z1^4)}{(S^2 \cdot (S_v)^2) / (4 \cdot \exp(2 \cdot Z1) \cdot Z1^4)} - \frac{(2 \cdot S^2 \cdot (S_v)^2) / (\exp(3 \cdot Z1) \cdot Z1^4)}{(S^2 \cdot (S_v)^2) / (4 \cdot \exp(2 \cdot Y \cdot Z1) \cdot Z1^4)} + \\
& + \frac{(9 \cdot \exp(-4 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (4 \cdot Z1^4)}{(4 \cdot \exp(-3 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^4)} - \frac{(6 \cdot \exp(-3 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^4)}{(11 \cdot \exp(-2 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (2 \cdot Z1^4)} + \\
& - \frac{(2 \cdot \exp(-Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^4)}{(9 \cdot \exp(-5 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (2 \cdot Z1^4)} - \frac{(9 \cdot \exp(-5 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (2 \cdot Z1^4)}{(12 \cdot \exp(-4 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^4)} - \frac{(11 \cdot \exp(-3 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^4)}{(22 \cdot S^2 \cdot (S_v)^2) / (\exp(4 \cdot Z1) \cdot Z1^3)} + \\
& + \frac{(4 \cdot \exp(-2 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^4)}{(12 \cdot S^2 \cdot (S_v)^2) / (\exp(5 \cdot Z1) \cdot Z1^3)} - \frac{(27 \cdot S^2 \cdot (S_v)^2) / (2 \cdot \exp(3 \cdot Z1) \cdot Z1^3)}{(S^2 \cdot (S_v)^2) / (2 \cdot \exp(Z1) \cdot Z1^3)} - \frac{(4 \cdot S^2 \cdot (S_v)^2) / (\exp(2 \cdot Z1) \cdot Z1^3)}{(S^2 \cdot (S_v)^2) / (2 \cdot \exp(3 \cdot Y \cdot Z1) \cdot Z1^3)} + \\
& - \frac{(S^2 \cdot (S_v)^2) / (2 \cdot \exp(Y \cdot Z1) \cdot Z1^3)}{(3 \cdot \exp(-2 \cdot Z1) - 3 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (2 \cdot Z1^3)} + \frac{(2 \cdot \exp(-2 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^3)}{(3 \cdot \exp(-3 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (2 \cdot Z1^3)} - \\
& + \frac{(9 \cdot \exp(-4 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^3)}{(9 \cdot \exp(-4 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^3) + (18 \cdot \exp(-3 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^3)} - \\
& - \frac{(25 \cdot \exp(-2 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (2 \cdot Z1^3)}{(9 \cdot S^2 \cdot Y \cdot (S_v)^2) / (2 \cdot \exp(5 \cdot Z1) \cdot Z1^3) + (12 \cdot S^2 \cdot Y \cdot (S_v)^2) / (\exp(4 \cdot Z1) \cdot Z1^3)} + \\
& - \frac{(11 \cdot S^2 \cdot Y \cdot (S_v)^2) / (\exp(3 \cdot Z1) \cdot Z1^3)}{(S^2 \cdot Y \cdot (S_v)^2) / (2 \cdot \exp(Y \cdot Z1) \cdot Z1^3)} + \frac{(4 \cdot S^2 \cdot Y \cdot (S_v)^2) / (\exp(2 \cdot Z1) \cdot Z1^3)}{(S^2 \cdot Y \cdot (S_v)^2) / (2 \cdot \exp(Z1) \cdot Z1^3) + (S^2 \cdot Y \cdot (S_v)^2) / (2 \cdot \exp(Y \cdot Z1) \cdot Z1^3)} - \\
& + \frac{(9 \cdot \exp(-4 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (Y \cdot (S_v)^2) / (2 \cdot Z1^3)}{(12 \cdot \exp(-3 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (Y \cdot (S_v)^2) / (Z1^3) + (11 \cdot \exp(-2 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (Y \cdot (S_v)^2) / (Z1^3)} - \\
& - \frac{(4 \cdot \exp(-Z1) - Y \cdot Z1) \cdot S^2 \cdot (Y \cdot (S_v)^2) / (Z1^3)}{(9 \cdot S^2 \cdot (S_v)^2) / (4 \cdot \exp(6 \cdot Z1) \cdot Z1^2)} - \frac{(3 \cdot S^2 \cdot (S_v)^2) / (\exp(5 \cdot Z1) \cdot Z1^2)}{(19 \cdot S^2 \cdot (S_v)^2) / (\exp(4 \cdot Z1) \cdot Z1^2)} + \\
& - \frac{(19 \cdot S^2 \cdot (S_v)^2) / (\exp(3 \cdot Z1) \cdot Z1^2)}{(2 \cdot S^2 \cdot (S_v)^2) / (\exp(Z1) \cdot Z1^2) + (S^2 \cdot (S_v)^2) / (4 \cdot \exp(4 \cdot Y \cdot Z1) \cdot Z1^2)} + \frac{(35 \cdot S^2 \cdot (S_v)^2) / (4 \cdot \exp(2 \cdot Z1) \cdot Z1^2)}{(S^2 \cdot (S_v)^2) / (2 \cdot \exp(2 \cdot Y \cdot Z1) \cdot Z1^2) + (exp(-Z1) - 3 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (2 \cdot Z1^2) + (5 \cdot \exp(-2 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^2) - (2 \cdot \exp(-Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^2)} - \\
& - \frac{(9 \cdot \exp(-5 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (4 \cdot Z1^2)}{(5 \cdot \exp(-3 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^2) - (\exp(-2 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1^2) \dots} + \frac{(exp(-Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (4 \cdot Z1^2)}{(S^2 \cdot Y \cdot (S_v)^2) / (2 \cdot \exp(4 \cdot Z1) \cdot Z1^2) + (26 \cdot S^2 \cdot Y \cdot (S_v)^2) / (\exp(3 \cdot Z1) \cdot Z1^2)} - \\
& - \frac{(29 \cdot S^2 \cdot Y \cdot (S_v)^2) / (2 \cdot \exp(2 \cdot Z1) \cdot Z1^2)}{(S^2 \cdot Y \cdot (S_v)^2) / (2 \cdot \exp(2 \cdot Y \cdot Z1) \cdot Z1^2) - (3 \cdot \exp(-2 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (2 \cdot Z1^2) \dots} + \frac{(4 \cdot S^2 \cdot Y \cdot (S_v)^2) / (\exp(Z1) \cdot Z1^2)}{(2 \cdot \exp(-Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (Z1^2) + (S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot Z1^2)} + \\
& \frac{(9 \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot \exp(6 \cdot Z1) \cdot Z1^2) - (6 \cdot S^2 \cdot Y \cdot (S_v)^2) / (\exp(5 \cdot Z1) \cdot Z1^2)}{(9 \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot \exp(4 \cdot Z1) \cdot Z1^2) - (8 \cdot S^2 \cdot Y \cdot (S_v)^2) / (\exp(3 \cdot Z1) \cdot Z1^2) + (23 \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot \exp(2 \cdot Z1) \cdot Z1^2) - (2 \cdot S^2 \cdot Y \cdot (S_v)^2) / (\exp(Z1) \cdot Z1^2) \dots} - \\
& - \frac{(9 \cdot \exp(-5 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot Z1^2)}{(Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (Z1^2) - (11 \cdot \exp(-3 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (2 \cdot Z1^2) \dots} + \frac{(2 \cdot \exp(-2 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (Z1^2) - (\exp(-Z1) - Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot Z1^2)}{(9 \cdot S^2 \cdot (S_v)^2) / (2 \cdot \exp(5 \cdot Z1) \cdot Z1) - (S^2 \cdot (S_v)^2) / (\exp(4 \cdot Z1) \cdot Z1) \dots} + \frac{(25 \cdot S^2 \cdot (S_v)^2) / (4 \cdot \exp(3 \cdot Z1) \cdot Z1)}{(3 \cdot S^2 \cdot (S_v)^2) / (4 \cdot \exp(Z1) \cdot Z1) + (3 \cdot \exp(-3 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (4 \cdot Z1) \dots} + \frac{(3 \cdot \exp(-Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (4 \cdot Z1)}{(3 \cdot \exp(-4 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1) + (2 \cdot \exp(-2 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot (S_v)^2) / (Z1) \dots} - \\
& - \frac{(9 \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot \exp(5 \cdot Z1) \cdot Z1)}{(11 \cdot S^2 \cdot Y \cdot (S_v)^2) / (\exp(3 \cdot Z1) \cdot Z1) + (7 \cdot S^2 \cdot Y \cdot (S_v)^2) / (\exp(2 \cdot Z1) \cdot Z1) \dots} - \frac{(7 \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot \exp(Z1) \cdot Z1) - (\exp(-Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (Z1) - (2 \cdot \exp(-2 \cdot Z1) - Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (Z1) + (15 \cdot S^2 \cdot Y \cdot (S_v)^2) / (2 \cdot \exp(5 \cdot Z1) \cdot Z1) \dots} - \\
& - \frac{(13 \cdot S^2 \cdot Y \cdot (S_v)^2) / (exp(4 \cdot Z1) \cdot Z1)}{(6 \cdot S^2 \cdot Y \cdot (S_v)^2) / (exp(2 \cdot Z1) \cdot Z1) + (5 \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot \exp(Z1) \cdot Z1) \dots} + \frac{(3 \cdot \exp(-3 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot Z1)}{(exp(-2 \cdot Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot Z1) + (exp(-Z1) - 2 \cdot Y \cdot Z1) \cdot S^2 \cdot Y \cdot (S_v)^2) / (4 \cdot Z1) \dots}
\end{aligned}$$

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    - (9*S^2.*Y.^3*(S_v)^2)/(4*exp(5*Z1)*Z1)      + (6*S^2.*Y.^3*(S_v)^2)/(exp(4*Z1)*Z1)      -
(11*S^2.*Y.^3*(S_v)^2)/(2*exp(3*Z1)*Z1) + (2*S^2.*Y.^3*(S_v)^2)/(exp(2*Z1)*Z1) ...
    - (S^2.*Y.^3*(S_v)^2)/(4*exp(Z1)*Z1)      - (3*S^2*Z1*(S_v)^2)/(4*exp(5*Z1))      -
(3*S^2*Z1*(S_v)^2)/(4*exp(3*Z1))      + (S^2.*Y.^Z1*(S_v)^2)/exp(3*Z1)      +
(S^2.*Y.^Z1*(S_v)^2)/exp(4*Z1) ...
    + (S^2.*Y.^2*Z1*(S_v)^2)/(2*exp(3*Z1))      - (S^2.*Y.^3*Z1*(S_v)^2)/exp(3*Z1)      +
(3*S^2.*Y.^4*Z1*(S_v)^2)/(4*exp(5*Z1)) - (S^2.*Y.^4*Z1*(S_v)^2)/exp(4*Z1) ...
    + (S^2.*Y.^4*Z1*(S_v)^2)/(4*exp(3*Z1))      + (S^2*Z1^2*(S_v)^2)/(4*exp(4*Z1))      -
(S^2.*Y.^2*Z1^2*(S_v)^2)/(2*exp(4*Z1)) + (S^2.*Y.^4*Z1^2*(S_v)^2)/(4*exp(4*Z1));

```

```

Ns1=Nf1+Nc+Ny1;
Phi1=Nf1./[Nc+Ny1];
Be1=1./[1+Phi1];
Gf1=Nf1./Ns1;
Gh1=[Nc+Ny1]./Ns1;
Nh1=Nc+Ny1;

```

```

Z2=7.5;
Nf2=Br*[(Z2^2).*exp(-2.*Y.*Z2)+(Z2^2)*exp(-2*Z2)-2*Z2^2.*exp(-Z2-Y.*Z2)];
Ny2=1 - exp(-2*Z2) + exp(-Z2 - Y.*Z2) - (2*S)/exp(2*Z2) + 2*exp(-Z2 - Y.*Z2)*S - S^2/exp(2*Z2) +
exp(-Z2 - Y.*Z2)*S^2 - 2.*Y + Y.^2 + Y.^2/exp(2*Z2) - exp(-Z2 - Y.*Z2).*Y.^2 ...
    + (2*S.*Y.^2)/exp(2*Z2) - 2*exp(-Z2 - Y.*Z2)*S.*Y.^2 + (S^2.*Y.^2)/exp(2*Z2) - exp(-Z2 - Y.*Z2)*S^2.*Y.^2 + 1/(exp(2*Z2)*Z2^2) + 1./(exp(2.*Y.*Z2)*Z2^2) ...
    - (2*exp(-Z2 - Y.*Z2))/Z2^2 + (2*S)/(exp(2*Z2)*Z2^2) + (2*S)./(exp(2.*Y.*Z2)*Z2^2) - (4*exp(-Z2 - Y.*Z2)*S)/Z2^2 + S^2/(exp(2*Z2)*Z2^2) + S^2./(exp(2.*Y.*Z2)*Z2^2) ...
    - (2*exp(-Z2 - Y.*Z2)*S^2)/Z2^2 + 2/(exp(2*Z2)*Z2) - 2./(exp(Y.*Z2)*Z2) + (2*S)/(exp(Z2)*Z2) - (2*S)./(exp(Y.*Z2)*Z2) - (2.*Y)/(exp(Z2)*Z2) + (2.*Y)/(exp(Y.*Z2)*Z2) ...
    - (2*S.*Y)/(exp(Z2)*Z2) + (2*S.*Y)/(exp(Y.*Z2)*Z2) - Z2/exp(Z2) - (S*Z2)/exp(Z2) + (Y.*Z2)/exp(Z2) + (S.*Y.*Z2)/exp(Z2) + (Y.^2*Z2)/exp(Z2) + (S.*Y.^2*Z2)/exp(Z2) - (Y.^3*Z2)/exp(Z2)
...
    - (S.*Y.^3*Z2)/exp(Z2) + Z2^2/(4*exp(2*Z2)) + (S*Z2^2)/(2*exp(2*Z2)) + (S^2*Z2^2)/(4*exp(2*Z2))
    - (Y.^2*Z2^2)/(2*exp(2*Z2)) - (S.*Y.^2*Z2^2)/exp(2*Z2) ...
    - (S^2.*Y.^2*Z2^2)/(2*exp(2*Z2)) + (Y.^4*Z2^2)/(4*exp(2*Z2)) + (S.*Y.^4*Z2^2)/(2*exp(2*Z2)) + (S^2.*Y.^4*Z2^2)/(4*exp(2*Z2)) - (7*S*(S_v))/(2*exp(3*Z2)) ...
    + (2*S*(S_v))/exp(2*Z2) + (S*(S_v))/exp(Z2) - (exp(-Z2 - 2.*Y.*Z2)*S*(S_v))/2 - (5*S^2*(S_v))/exp(3*Z2) + (2*S^2*(S_v))/exp(2*Z2) - (S^2*(S_v))/(2*exp(Z2)) ...
    - (exp(-Z2 - 2.*Y.*Z2)*S^2*(S_v))/2 - (2*S.*Y.(S_v))/exp(2*Z2) - (3*S.*Y.(S_v))/exp(Z2) + (3*S^2.*Y.(S_v))/(2*exp(3*Z2)) - (2*S^2.*Y.(S_v))/exp(2*Z2) ...
    + (S^2.*Y.(S_v))/(2*exp(Z2)) + (13*S.*Y.^2*(S_v))/(2*exp(3*Z2)) - (4*S.*Y.^2*(S_v))/exp(2*Z2) + (3*S.*Y.^2*(S_v))/exp(Z2) + (exp(-Z2 - 2.*Y.*Z2)*S.*Y.^2*(S_v))/2 ...
    + (5*S^2.*Y.^2*(S_v))/exp(3*Z2) - (2*S^2.*Y.^2*(S_v))/exp(2*Z2) + (S^2.*Y.^2*(S_v))/(2*exp(Z2)) +
(exp(-Z2 - 2.*Y.*Z2)*S^2.*Y.^2*(S_v))/2 - (3*S.*Y.^3*(S_v))/exp(3*Z2) ...
    + (4*S.*Y.^3*(S_v))/exp(2*Z2) - (S.*Y.^3*(S_v))/exp(Z2) - (3*S^2.*Y.^3*(S_v))/(2*exp(3*Z2)) + (2*S^2.*Y.^3*(S_v))/exp(2*Z2) - (S^2.*Y.^3*(S_v))/(2*exp(Z2)) ...
    + (3*S*(S_v))/(exp(4*Z2)*Z2^3) - (4*S*(S_v))/(exp(3*Z2)*Z2^3) + (S*(S_v))/(exp(2*Z2)*Z2^3) + (S*(S_v))./(exp(2.*Y.*Z2)*Z2^3) + (3*exp(-2*Z2 - 2.*Y.*Z2)*S*(S_v))/Z2^3 ...
    - (4*exp(-Z2 - 2.*Y.*Z2)*S*(S_v))/Z2^3 - (6*exp(-3*Z2 - Y.*Z2)*S*(S_v))/Z2^3 + (8*exp(-2*Z2 - Y.*Z2)*S*(S_v))/Z2^3 - (2*exp(-Z2 - Y.*Z2)*S*(S_v))/Z2^3 ...
    + (3*S^2*(S_v))/(exp(4*Z2)*Z2^3) - (4*S^2*(S_v))/(exp(3*Z2)*Z2^3) + (3*exp(-2*Z2 - 2.*Y.*Z2)*S^2*(S_v))/Z2^3 ...
    - (4*exp(-Z2 - 2.*Y.*Z2)*S^2*(S_v))/Z2^3 - (6*exp(-3*Z2 - Y.*Z2)*S^2*(S_v))/Z2^3 + (8*exp(-2*Z2 - Y.*Z2)*S^2*(S_v))/Z2^3 - (2*exp(-Z2 - Y.*Z2)*S^2*(S_v))/Z2^3 ...
    + (11*S*(S_v))/(exp(3*Z2)*Z2^2) - (8*S*(S_v))/(exp(2*Z2)*Z2^2) + (2*S*(S_v))/(exp(Z2)*Z2^2) - (S*(S_v))./(exp(3.*Y.*Z2)*Z2^2) - (2*S*(S_v))./(exp(Y.*Z2)*Z2^2) ...

```

$$\begin{aligned}
& - (\exp(-Z2 - 2.*Y.*Z2)*S*(S_v))/Z2^2 - (9*\exp(-2*Z2 - Y.*Z2)*S*(S_v))/Z2^2 + (8*\exp(-Z2 - Y.*Z2)*S*(S_v))/Z2^2 + (8*S^2*(S_v))/(exp(3*Z2)*Z2^2); \dots \\
& - (4*S^2*(S_v))/(exp(2*Z2)*Z2^2) + (S^2*(S_v))/(exp(Z2)*Z2^2) - (\exp(-Z2 - 2.*Y.*Z2)*S^2*(S_v))/Z2^2 \dots \\
& (S^2*(S_v))/(exp(3.*Y.*Z2)*Z2^2) - (S^2*(S_v))/(exp(Y.*Z2)*Z2^2) - (\exp(-Z2 - 2.*Y.*Z2)*S^2*(S_v))/Z2^2 \dots \\
& - (6*\exp(-2*Z2 - Y.*Z2)*S^2*(S_v))/Z2^2 + (4*\exp(-Z2 - Y.*Z2)*S^2*(S_v))/Z2^2 - (6*S.*Y.(S_v))/(exp(3*Z2)*Z2^2) + (8*S.*Y.(S_v))/(exp(2*Z2)*Z2^2) \dots \\
& - (2*S.*Y.(S_v))/(exp(Z2)*Z2^2) + (2*S.*Y.(S_v))/(exp(Y.*Z2)*Z2^2) + (6*\exp(-2*Z2 - Y.*Z2)*S.*Y.(S_v))/Z2^2 \dots \\
& - (3*S^2.*Y.(S_v))/(exp(3*Z2)*Z2^2) + (4*S^2.*Y.(S_v))/(exp(2*Z2)*Z2^2) - (S^2.*Y.(S_v))/(exp(Z2)*Z2^2) + (S^2.*Y.(S_v))/(exp(3*Z2)*Z2^2) \dots \\
& + (3*\exp(-2*Z2 - Y.*Z2)*S^2.*Y.(S_v))/Z2^2 - (4*\exp(-Z2 - Y.*Z2)*S^2.*Y.(S_v))/Z2^2 + (S*(S_v))/Z2 + (2*S*(S_v))/(exp(3*Z2)*Z2) + (9*S*(S_v))/(exp(2*Z2)*Z2) \dots \\
& - (4*S*(S_v))/(exp(Z2)*Z2) + (S*(S_v))/(exp(2.*Y.*Z2)*Z2) - (2*\exp(-2*Z2 - Y.*Z2)*S*(S_v))/Z2 + (\exp(-Z2 - Y.*Z2)*S*(S_v))/Z2 + (2*S^2*(S_v))/(exp(3*Z2)*Z2) \dots \\
& + (S^2*(S_v))/(exp(2*Z2)*Z2) - (2*\exp(-2*Z2 - Y.*Z2)*S^2*(S_v))/Z2 - (\exp(-Z2 - Y.*Z2)*S^2*(S_v))/Z2 - (13*S.*Y.(S_v))/(exp(2*Z2)*Z2) \dots \\
& + (8*S.*Y.(S_v))/(exp(Z2)*Z2) - (S.*Y.(S_v))/(exp(2.*Y.*Z2)*Z2) - (2*S^2.*Y.(S_v))/(exp(2*Z2)*Z2) + (S.*Y.^2*(S_v))/(Z2 + (S.*Y.^2*(S_v))/(exp(3*Z2)*Z2) \dots \\
& + (3*S.*Y.^2*(S_v))/(exp(4*Z2)*Z2) - (4*S.*Y.^2*(S_v))/(exp(Z2)*Z2) - (3*S^2.*Y.^2*(S_v))/(exp(2*Z2)*Z2) + (4*S.*Y.^2*(S_v))/(exp(2*Z2)*Z2) \dots \\
& - (3*\exp(-3*Z2 - Y.*Z2)*S.*Y.^2*(S_v))/Z2 + (4*\exp(-2*Z2 - Y.*Z2)*S.*Y.^2*(S_v))/Z2 - (\exp(-Z2 - Y.*Z2)*S.*Y.^2*(S_v))/Z2 + (3*S^2.*Y.^2*(S_v))/(exp(4*Z2)*Z2) \dots \\
& - (4*S^2.*Y.^2*(S_v))/(exp(3*Z2)*Z2) + (S^2.*Y.^2*(S_v))/(exp(2*Z2)*Z2) - (3*\exp(-3*Z2 - Y.*Z2)*S^2.*Y.^2*(S_v))/Z2 + (4*\exp(-2*Z2 - Y.*Z2)*S^2.*Y.^2*(S_v))/Z2 \dots \\
& - (\exp(-Z2 - Y.*Z2)*S^2.*Y.^2*(S_v))/Z2 - (3*S^2*Z2*(S_v))/(4*\exp(4*Z2)) - (7*S^2*Z2*(S_v))/(4*\exp(2*Z2)) - (3*S^2*Z2*(S_v))/(4*\exp(4*Z2)) - (3*S^2*Z2*(S_v))/(4*\exp(2*Z2)) \dots \\
& + (2*S.*Y.*Z2*(S_v))/(exp(2*Z2) + (S^2.*Y.*Z2*(S_v))/(exp(2*Z2) + (S.*Y.^2*Z2*(S_v))/(exp(3*Z2) + (3*S.*Y.^2*Z2*(S_v))/(2*\exp(2*Z2)) + (S^2.*Y.^2*Z2*(S_v))/(exp(3*Z2) \dots \\
& + (S^2.*Y.^2*Z2*(S_v))/(2*\exp(2*Z2)) + (S^2.*Y.^2*Z2*(S_v))/(exp(3*Z2) \dots \\
& + (S^2.*Y.^2*Z2*(S_v))/(2*\exp(2*Z2)) - (2*S.*Y.^2*Z2*(S_v))/(exp(2*Z2)) - (3*S.*Y.^4*Z2*(S_v))/(4*\exp(4*Z2)) - (S^2.*Y.^4*Z2*(S_v))/(exp(2*Z2) \dots \\
& + (S.*Y.^4*Z2*(S_v))/(exp(3*Z2) \dots \\
& + (S.*Y.^4*Z2*(S_v))/(4*\exp(2*Z2)) + (S^2.*Y.^4*Z2*(S_v))/(4*\exp(2*Z2)) - (S^2*Z2^2*(S_v))/(2*\exp(3*Z2)) \dots \\
& + (S^2*Z2^2*(S_v))/(2*\exp(3*Z2)) - (S^2.*Y.^2*Z2^2*(S_v))/(exp(3*Z2)) - (S.*Y.^2*Z2^2*(S_v))/(exp(3*Z2) \dots \\
& + (S^2.*Y.^2*Z2^2*(S_v))/(exp(3*Z2)) + (S.*Y.^4*Z2^2*(S_v))/(2*\exp(3*Z2) \dots \\
& + (S^2.*Y.^4*Z2^2*(S_v))/(2*\exp(3*Z2)) + (9*S^2*(S_v)^2)/(16*\exp(6*Z2)) - (23*S^2*(S_v)^2)/(8*\exp(4*Z2)) + (2*S^2*(S_v)^2)/(exp(3*Z2) + (S^2*(S_v)^2)/(16*\exp(2*Z2)) \dots \\
& - (\exp(-2*Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/2 - \exp(-3*Z2 - Y.*Z2)*S^2*(S_v)^2 - (2*S^2.*Y.(S_v)^2)/(exp(3*Z2) - (S^2.*Y.(S_v)^2)/(exp(2*Z2) + (9*S^2.*Y.(S_v)^2)/(8*\exp(6*Z2)) \dots \\
& \dots \\
& - (3*S^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z2)) + (11*S^2.*Y.^2*(S_v)^2)/(2*\exp(4*Z2)) - (7*S^2.*Y.^2*(S_v)^2)/(2*\exp(3*Z2)) + (15*S^2.*Y.^2*(S_v)^2)/(8*\exp(2*Z2)) \dots \\
& + (\exp(-2*Z2 - 2.*Y.*Z2)*S^2.*Y.^2*(S_v)^2)/2 + \exp(-3*Z2 - Y.*Z2)*S^2.*Y.^2*(S_v)^2 - (3*S^2.*Y.^3*(S_v)^2)/(exp(4*Z2) + (4*S^2.*Y.^3*(S_v)^2)/(exp(3*Z2) \dots \\
& - (S^2.*Y.^3*(S_v)^2)/(exp(2*Z2)) + (9*S^2.*Y.^4*(S_v)^2)/(16*\exp(6*Z2)) - (3*S^2.*Y.^4*(S_v)^2)/(2*\exp(5*Z2)) + (11*S^2.*Y.^4*(S_v)^2)/(8*\exp(4*Z2)) \dots \\
& - (S^2.*Y.^4*(S_v)^2)/(2*\exp(3*Z2)) + (S^2.*Y.^4*(S_v)^2)/(16*\exp(2*Z2)) - (9*S^2*(S_v)^2)/(4*\exp(6*Z2)*Z2^4) - (6*S^2*(S_v)^2)/(exp(5*Z2)*Z2^4) \dots \\
& + (11*S^2*(S_v)^2)/(2*\exp(4*Z2)*Z2^4) - (2*S^2*(S_v)^2)/(exp(3*Z2)*Z2^4) - (S^2*(S_v)^2)/(4*\exp(2*Z2)*Z2^4) + (S^2*(S_v)^2)/(4*\exp(2*Z2)*Z2^4) \dots \\
& + (9*\exp(-4*Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/(4*Z2^4) - (6*\exp(-3*Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/(Z2^4) + (11*\exp(-2*Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/(2*Z2^4) \dots \\
& - (2*\exp(-Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/(Z2^4) - (9*\exp(-5*Z2 - Y.*Z2)*S^2*(S_v)^2)/(2*Z2^4) + (12*\exp(-4*Z2 - Y.*Z2)*S^2*(S_v)^2)/(Z2^4) - (11*\exp(-3*Z2 - Y.*Z2)*S^2*(S_v)^2)/(Z2^4) \dots
\end{aligned}$$

$$\begin{aligned}
& + (4*\exp(-2*Z2 - Y.*Z2)*S^2*(S_v)^2)/Z2^4 - (\exp(-Z2 - Y.*Z2)*S^2*(S_v)^2)/(2*Z2^4) + \\
& (12*S^2*(S_v)^2)/(\exp(5*Z2)*Z2^3) - (22*S^2*(S_v)^2)/(\exp(4*Z2)*Z2^3) ... \\
& + (27*S^2*(S_v)^2)/(2*\exp(3*Z2)*Z2^3) - (4*S^2*(S_v)^2)/(\exp(2*Z2)*Z2^3) + \\
& (S^2*(S_v)^2)/(2*\exp(Z2)*Z2^3) - (S^2*(S_v)^2)/(2*\exp(3.*Y.*Z2)*Z2^3) ... \\
& - (S^2*(S_v)^2)/(2*\exp(Y.*Z2)*Z2^3) - (3*\exp(-2*Z2 - 3.*Y.*Z2)*S^2*(S_v)^2)/(2*Z2^3) + (2*\exp(- \\
& Z2 - 3.*Y.*Z2)*S^2*(S_v)^2)/Z2^3 - (3*\exp(-3*Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/(2*Z2^3) ... \\
& + (2*\exp(-2*Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/Z2^3 - (\exp(-Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/(2*Z2^3) - \\
& (9*\exp(-4*Z2 - Y.*Z2)*S^2*(S_v)^2)/Z2^3 + (18*\exp(-3*Z2 - Y.*Z2)*S^2*(S_v)^2)/Z2^3 ... \\
& - (25*\exp(-2*Z2 - Y.*Z2)*S^2*(S_v)^2)/(2*Z2^3) + (4*\exp(-Z2 - Y.*Z2)*S^2*(S_v)^2)/Z2^3 - \\
& (9*S^2.*Y.(S_v)^2)/(2*\exp(5*Z2)*Z2^3) + (12*S^2.*Y.(S_v)^2)/(\exp(4*Z2)*Z2^3) ... \\
& - (11*S^2.*Y.(S_v)^2)/(\exp(3*Z2)*Z2^3) + (4*S^2.*Y.(S_v)^2)/(\exp(2*Z2)*Z2^3) - \\
& (S^2.*Y.(S_v)^2)/(2*\exp(Z2)*Z2^3) + (S^2.*Y.(S_v)^2)/(2*\exp(Y.*Z2)*Z2^3) ... \\
& + (9*\exp(-4*Z2 - Y.*Z2)*S^2.*Y.(S_v)^2)/(2*Z2^3) - (12*\exp(-3*Z2 - Y.*Z2)*S^2.*Y.(S_v)^2)/Z2^3 ... \\
& - (4*\exp(-Z2 - Y.*Z2)*S^2.*Y.(S_v)^2)/Z2^3 + (S^2*(S_v)^2)/(4*Z2^2) + \\
& (9*S^2*(S_v)^2)/(4*\exp(6*Z2)*Z2^2) - (3*S^2*(S_v)^2)/(exp(5*Z2)*Z2^2) + \\
& (19*S^2*(S_v)^2)/(exp(4*Z2)*Z2^2) ... \\
& - (19*S^2*(S_v)^2)/(exp(3*Z2)*Z2^2) + (35*S^2*(S_v)^2)/(4*\exp(2*Z2)*Z2^2) - \\
& (2*S^2*(S_v)^2)/(exp(Z2)*Z2^2) + (S^2*(S_v)^2)/(4*\exp(4.*Y.*Z2)*Z2^2) ... \\
& + (S^2*(S_v)^2)/(2*\exp(2.*Y.*Z2)*Z2^2) + (\exp(-Z2 - 3.*Y.*Z2)*S^2*(S_v)^2)/Z2^2 + (5*\exp(-2*Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/Z2^2 - (2*\exp(-Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/Z2^2 ... \\
& - (9*\exp(-5*Z2 - Y.*Z2)*S^2*(S_v)^2)/(4*Z2^2) + (3*\exp(-4*Z2 - Y.*Z2)*S^2*(S_v)^2)/Z2^2 + (5*\exp(-3*Z2 - Y.*Z2)*S^2*(S_v)^2)/Z2^2 - (\exp(-2*Z2 - Y.*Z2)*S^2*(S_v)^2)/Z2^2 ... \\
& + (\exp(-Z2 - Y.*Z2)*S^2*(S_v)^2)/(4*Z2^2) - (S^2.*Y.(S_v)^2)/(2*Z2^2) - \\
& (15*S^2.*Y.(S_v)^2)/(exp(4*Z2)*Z2^2) + (26*S^2.*Y.(S_v)^2)/(exp(3*Z2)*Z2^2) ... \\
& - (29*S^2.*Y.(S_v)^2)/(2*\exp(2.*Y.*Z2)*Z2^2) + (4*S^2.*Y.(S_v)^2)/(exp(Z2)*Z2^2) - \\
& (S^2.*Y.(S_v)^2)/(2*\exp(2.*Y.*Z2)*Z2^2) - (3*\exp(-2*Z2 - 2.*Y.*Z2)*S^2.*Y.(S_v)^2)/(2*Z2^2) ... \\
& + (2*\exp(-Z2 - 2.*Y.*Z2)*S^2.*Y.(S_v)^2)/Z2^2 + (S^2.*Y.^2*(S_v)^2)/(4*Z2^2) + \\
& (9*S^2.*Y.^2*(S_v)^2)/(4*\exp(6*Z2)*Z2^2) - (6*S^2.*Y.^2*(S_v)^2)/(exp(5*Z2)*Z2^2) ... \\
& + (31*S^2.*Y.^2*(S_v)^2)/(4*\exp(4*Z2)*Z2^2) - (8*S^2.*Y.^2*(S_v)^2)/(exp(3*Z2)*Z2^2) + \\
& (23*S^2.*Y.^2*(S_v)^2)/(4*\exp(2*Z2)*Z2^2) - (2*S^2.*Y.^2*(S_v)^2)/(exp(Z2)*Z2^2) ... \\
& - (9*\exp(-5*Z2 - Y.*Z2)*S^2.*Y.^2*(S_v)^2)/(4*Z2^2) + (6*\exp(-4*Z2 - Y.*Z2)*S^2.*Y.^2*(S_v)^2)/(Z2^2) - (11*\exp(-3*Z2 - Y.*Z2)*S^2.*Y.^2*(S_v)^2)/(2*Z2^2) ... \\
& + (2*\exp(-2*Z2 - Y.*Z2)*S^2.*Y.^2*(S_v)^2)/Z2^2 - (\exp(-Z2 - Y.*Z2)*S^2.*Y.^2*(S_v)^2)/(4*Z2^2) + (9*S^2*(S_v)^2)/(2*\exp(5*Z2)*Z2) - (S^2*(S_v)^2)/(exp(4*Z2)*Z2) ... \\
& + (25*S^2*(S_v)^2)/(4*\exp(3*Z2)*Z2) - (3*S^2*(S_v)^2)/(exp(2*Z2)*Z2) + (3*S^2*(S_v)^2)/(4*\exp(2*Z2)*Z2) + (3*S^2*(S_v)^2)/(4*\exp(3*Z2)*Z2) + (3*\exp(-3*Z2 - 2.*Y.*Z2)*S^2*(S_v)^2)/(4*Z2) + (3*\exp(-4*Z2 - Y.*Z2)*S^2*(S_v)^2)/Z2 - (2*\exp(-3*Z2 - Y.*Z2)*S^2*(S_v)^2)/Z2 + (2*\exp(-2*Z2 - Y.*Z2)*S^2*(S_v)^2)/Z2 - (9*S^2.*Y.(S_v)^2)/(4*\exp(5*Z2)*Z2) + (3*S^2.*Y.(S_v)^2)/(exp(4*Z2)*Z2) - \\
& (11*S^2.*Y.(S_v)^2)/(exp(3*Z2)*Z2) + (7*S^2.*Y.(S_v)^2)/(exp(2*Z2)*Z2) ... \\
& - (7*S^2.*Y.(S_v)^2)/(4*\exp(Z2)*Z2) - (\exp(-Z2 - 2.*Y.*Z2)*S^2.*Y.(S_v)^2)/Z2 - (2*\exp(-2*Z2 - Y.*Z2)*S^2.*Y.(S_v)^2)/Z2 + (15*S^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z2)*Z2) ... \\
& - (13*S^2.*Y.^2*(S_v)^2)/(exp(4*Z2)*Z2) + (41*S^2.*Y.^2*(S_v)^2)/(4*\exp(3*Z2)*Z2) - (6*S^2.*Y.^2*(S_v)^2)/(exp(2*Z2)*Z2) + (5*S^2.*Y.^2*(S_v)^2)/(4*\exp(Z2)*Z2) ... \\
& + (3*\exp(-3*Z2 - 2.*Y.*Z2)*S^2.*Y.^2*(S_v)^2)/(4*Z2) - (\exp(-2*Z2 - 2.*Y.*Z2)*S^2.*Y.^2*(S_v)^2)/(4*Z2) ... \\
& 2.*Y.*Z2)*S^2.*Y.^2*(S_v)^2)/Z2 + (\exp(-Z2 - 2.*Y.*Z2)*S^2.*Y.^2*(S_v)^2)/(4*Z2) ... \\
& - (9*S^2.*Y.^2*(S_v)^2)/(4*\exp(5*Z2)*Z2) + (6*S^2.*Y.^2*(S_v)^2)/(exp(4*Z2)*Z2) - \\
& (11*S^2.*Y.^2*(S_v)^2)/(2*\exp(3*Z2)*Z2) + (2*S^2.*Y.^2*(S_v)^2)/(exp(2*Z2)*Z2) ... \\
& - (S^2.*Y.^2*(S_v)^2)/(4*\exp(Z2)*Z2) - (3*S^2*Z2*(S_v)^2)/(4*\exp(5*Z2)) + (S^2.*Y.*Z2*(S_v)^2)/(exp(3*Z2)) + (S^2.*Y.^2*Z2*(S_v)^2)/(exp(4*Z2)) ... \\
& + (S^2.*Y.^2*Z2*(S_v)^2)/(2*\exp(3*Z2)) - (S^2.*Y.^2*Z2*(S_v)^2)/(exp(3*Z2)) + (S^2.*Y.^2*Z2*(S_v)^2)/(4*\exp(4*Z2)) - \\
& (S^2.*Y.^2*Z2*(S_v)^2)/(2*\exp(4*Z2)) + (S^2.*Y.^2*Z2*(S_v)^2)/(4*\exp(4*Z2)); 
\end{aligned}$$

```

Ns2=Nf2+Nc+Ny2;
Phi2=Nf2./[Nc+Ny2];
Be2=1./[1+Phi2];
Gf2=Nf2./Ns2;
Gh2=[Nc+Ny2]./Ns2;
Nh2=Nc+Ny2;

Z3=10;
Nf3=Br*[(Z3^2).*exp(-2.*Y.*Z3)+(Z3^2)*exp(-2*Z3)-2*Z3^2.*exp(-Z3-Y.*Z3)];
Ny3=1 - exp(-2*Z3) + exp(-Z3 - Y.*Z3) - (2*S)/exp(2*Z3) + 2*exp(-Z3 - Y.*Z3)*S - S^2/exp(2*Z3) +
exp(-Z3 - Y.*Z3)*S^2 - 2.*Y + Y.^2 + Y.^2/exp(2*Z3) - exp(-Z3 - Y.*Z3).*Y.^2 ...
+ (2*S.*Y.^2)/exp(2*Z3) - 2*exp(-Z3 - Y.*Z3)*S.*Y.^2 + (S^2.*Y.^2)/exp(2*Z3) - exp(-Z3 -
Y.*Z3)*S^2.*Y.^2 + 1/(exp(2*Z3)*Z3^2) + 1./(exp(2.*Y.*Z3)*Z3^2) ...
- (2*exp(-Z3 - Y.*Z3))/Z3^2 + (2*S)/(exp(2*Z3)*Z3^2) + (2*S)./(exp(2.*Y.*Z3)*Z3^2) - (4*exp(-Z3 -
Y.*Z3)*S)/Z3^2 + S^2/(exp(2*Z3)*Z3^2) + S^2./(exp(2.*Y.*Z3)*Z3^2) ...
- (2*exp(-Z3 - Y.*Z3)*S^2)/Z3^2 + 2/(exp(Z3)*Z3) - 2./((exp(Y.*Z3)*Z3) + (2*S)/(exp(Z3)*Z3) -
(2*S)./(exp(Y.*Z3)*Z3) - (2.*Y)/(exp(Z3)*Z3) + (2.*Y)/(exp(Y.*Z3)*Z3) ...
- (2*S.*Y)/(exp(Z3)*Z3) + (2*S.*Y)/(exp(Y.*Z3)*Z3) - Z3/exp(Z3) - (S*Z3)/exp(Z3) +
(Y.*Z3)/exp(Z3) + (S.*Y.*Z3)/exp(Z3) + (Y.^2*Z3)/exp(Z3) + (S.*Y.^2*Z3)/exp(Z3) - (Y.^3*Z3)/exp(Z3)
...
- (S.*Y.^3*Z3)/exp(Z3) + Z3^2/(4*exp(2*Z3)) + (S*Z3^2)/(2*exp(2*Z3)) + (S^2*Z3^2)/(4*exp(2*Z3))
- (Y.^2*Z3^2)/(2*exp(2*Z3)) - (S.*Y.^2*Z3^2)/exp(2*Z3) ...
- (S^2.*Y.^2*Z3^2)/(2*exp(2*Z3)) + (Y.^4*Z3^2)/(4*exp(2*Z3)) + (S.*Y.^4*Z3^2)/(2*exp(2*Z3)) +
(S^2.*Y.^4*Z3^2)/(4*exp(2*Z3)) - (7*S*(S_v))/(2*exp(3*Z3)) ...
+ (2*S*(S_v))/exp(2*Z3) + (S*(S_v))/exp(Z3) - (exp(-Z3 - 2.*Y.*Z3)*S*(S_v))/2 -
(5*S^2*(S_v))/exp(3*Z3) + (2*S^2*(S_v))/exp(2*Z3) - (S^2*(S_v))/(2*exp(Z3)) ...
- (exp(-Z3 - 2.*Y.*Z3)*S^2*(S_v))/2 - (2*S.*Y.*(S_v))/exp(2*Z3) - (3*S.*Y.*(S_v))/exp(Z3) +
(3*S^2.*Y.*(S_v))/(2*exp(3*Z3)) - (2*S^2.*Y.*(S_v))/exp(2*Z3) ...
+ (S^2.*Y.*(S_v))/(2*exp(Z3)) + (13*S.*Y.^2*(S_v))/(2*exp(3*Z3)) - (4*S.*Y.^2*(S_v))/exp(2*Z3) +
(3*S.*Y.^2*(S_v))/exp(Z3) + (exp(-Z3 - 2.*Y.*Z3)*S.*Y.^2*(S_v))/2 ...
+ (5*S^2.*Y.^2*(S_v))/exp(3*Z3) - (2*S^2.*Y.^2*(S_v))/exp(2*Z3) + (S^2.*Y.^2*(S_v))/(2*exp(Z3)) +
(exp(-Z3 - 2.*Y.*Z3)*S^2.*Y.^2*(S_v))/2 - (3*S.*Y.^3*(S_v))/exp(3*Z3) ...
+ (4*S.*Y.^3*(S_v))/exp(2*Z3) - (S.*Y.^3*(S_v))/exp(Z3) - (3*S^2.*Y.^3*(S_v))/(2*exp(3*Z3)) +
(2*S^2.*Y.^3*(S_v))/exp(2*Z3) - (S^2.*Y.^3*(S_v))/(2*exp(Z3)) ...
+ (3*S*(S_v))/(exp(4*Z3)*Z3^3) - (4*S*(S_v))/(exp(3*Z3)*Z3^3) + (S*(S_v))/(exp(2*Z3)*Z3^3) +
(S*(S_v))./(exp(2.*Y.*Z3)*Z3^3) + (3*exp(-2*Z3 - 2.*Y.*Z3)*S*(S_v))/Z3^3 ...
- (4*exp(-Z3 - 2.*Y.*Z3)*S*(S_v))/Z3^3 - (6*exp(-3*Z3 - Y.*Z3)*S*(S_v))/Z3^3 + (8*exp(-2*Z3 -
Y.*Z3)*S*(S_v))/Z3^3 - (2*exp(-Z3 - Y.*Z3)*S*(S_v))/Z3^3 ...
+ (3*S^2*(S_v))/(exp(4*Z3)*Z3^3) - (4*S^2*(S_v))/(exp(3*Z3)*Z3^3) + (S^2*(S_v))/(exp(2*Z3)*Z3^3) -
(S^2*(S_v))./(exp(2*Z3)*Z3^3) + (S^2*(S_v))./(exp(2.*Y.*Z3)*Z3^3) + (3*exp(-2*Z3 -
2.*Y.*Z3)*S^2*(S_v))/Z3^3 ...
- (4*exp(-Z3 - 2.*Y.*Z3)*S^2*(S_v))/Z3^3 - (6*exp(-3*Z3 - Y.*Z3)*S^2*(S_v))/Z3^3 + (8*exp(-2*Z3 -
Y.*Z3)*S^2*(S_v))/Z3^3 - (2*exp(-Z3 - Y.*Z3)*S^2*(S_v))/Z3^3 ...
+ (11*S*(S_v))/(exp(3*Z3)*Z3^2) - (8*S*(S_v))/(exp(2*Z3)*Z3^2) + (2*S*(S_v))/(exp(Z3)*Z3^2) -
(S*(S_v))./(exp(3.*Y.*Z3)*Z3^2) - (2*S*(S_v))./(exp(Y.*Z3)*Z3^2) ...
- (exp(-Z3 - 2.*Y.*Z3)*S*(S_v))/Z3^2 - (9*exp(-2*Z3 - Y.*Z3)*S*(S_v))/Z3^2 + (8*exp(-Z3 -
Y.*Z3)*S*(S_v))/Z3^2 + (8*S^2*(S_v))/(exp(3*Z3)*Z3^2); ...
- (4*S^2*(S_v))/(exp(2*Z3)*Z3^2) + (S^2*(S_v))/(exp(Z3)*Z3^2) - (exp(-Z3 -
2.*Y.*Z3)*S^2*(S_v))/Z3^2 ...
- (6*exp(-2*Z3 - Y.*Z3)*S^2*(S_v))/Z3^2 + (4*exp(-Z3 - Y.*Z3)*S^2*(S_v))/Z3^2 - (6*S.*Y.*(S_v))/(exp(3*Z3)*Z3^2) + (8*S.*Y.*(S_v))/(exp(2*Z3)*Z3^2) ...
- (2*S.*Y.*(S_v))/(exp(Z3)*Z3^2) + (2*S.*Y.*(S_v))/(exp(Y.*Z3)*Z3^2) + (6*exp(-2*Z3 -
Y.*Z3)*S.*Y.*(S_v))/Z3^2 - (8*exp(-Z3 - Y.*Z3)*S.*Y.*(S_v))/Z3^2 ...

```

$$\begin{aligned}
& - \frac{(3*S^2.*Y.*(S_v))/(exp(3*Z3)*Z3^2)}{(S^2.*Y.*(S_v))/(exp(Z3)*Z3^2) + (S^2.*Y.*(S_v))/(exp(Y.*Z3)*Z3^2)} + \frac{(4*S^2.*Y.*(S_v))/(exp(2*Z3)*Z3^2)}{(S^2.*Y.*(S_v))/(exp(Z3)*Z3^2) + (S^2.*Y.*(S_v))/(exp(Y.*Z3)*Z3^2)} \\
& + \frac{(3*exp(-2*Z3 - Y.*Z3)*S^2.*Y.*(S_v))/Z3^2}{(S*(S_v))/Z3 + (2*S*(S_v))/(exp(3*Z3)*Z3) + (9*S*(S_v))/(exp(2*Z3)*Z3)} - \frac{(4*exp(-Z3 - Y.*Z3)*S^2.*Y.*(S_v))/Z3^2}{(S*(S_v))/Z3 + (2*S*(S_v))/(exp(3*Z3)*Z3) + (9*S*(S_v))/(exp(2*Z3)*Z3)} \\
& - \frac{(4*S*(S_v))/(exp(Z3)*Z3) + (S*(S_v))/(exp(2.*Y.*Z3)*Z3)}{(exp(-2*Z3 - Y.*Z3)*S*(S_v))/Z3 + (2*S^2*(S_v))/(exp(3*Z3)*Z3)} - \frac{(2*exp(-2*Z3 - Y.*Z3)*S*(S_v))/Z3}{(exp(-Z3 - Y.*Z3)*S*(S_v))/Z3 + (2*S^2*(S_v))/(exp(3*Z3)*Z3)} \\
& + \frac{(S^2*(S_v))/(exp(2*Z3)*Z3) - (2*exp(-2*Z3 - Y.*Z3)*S^2*(S_v))/Z3}{(exp(-Z3 - Y.*Z3)*S^2*(S_v))/Z3 - (2*S.*Y.*(S_v))/(exp(2*Z3)*Z3)} - \frac{(exp(-Z3 - Y.*Z3)*S^2*(S_v))/Z3 - (13*S.*Y.*(S_v))/(exp(2*Z3)*Z3)}{(2*S^2.*Y.*(S_v))/(exp(2*Z3)*Z3) + (2*exp(-Z3 - Y.*Z3)*S^2.*Y.*(S_v))/Z3 + (S.*Y.^2*(S_v))/Z3} \\
& + \frac{(3*S.*Y.^2*(S_v))/(exp(4*Z3)*Z3) - (4*S.*Y.^2*(S_v))/(exp(3*Z3)*Z3)}{(4*S.*Y.^2*(S_v))/(exp(2*Z3)*Z3) - (4*S.*Y.^2*(S_v))/(exp(Z3)*Z3)} \\
& - \frac{(3*exp(-3*Z3 - Y.*Z3)*S.*Y.^2*(S_v))/Z3 + (4*exp(-2*Z3 - Y.*Z3)*S.*Y.^2*(S_v))/Z3}{(exp(-Z3 - Y.*Z3)*S.*Y.^2*(S_v))/Z3 + (3*S^2.*Y.^2*(S_v))/(exp(4*Z3)*Z3)} \\
& - \frac{(4*S^2.*Y.^2*(S_v))/(exp(3*Z3)*Z3) + (S^2.*Y.^2*(S_v))/(exp(2*Z3)*Z3) - (3*exp(-3*Z3 - Y.*Z3)*S.*Y.^2*(S_v))/Z3}{(Y.*Z3)*S.*Y.^2*(S_v))/Z3 + (4*exp(-2*Z3 - Y.*Z3)*S^2.*Y.^2*(S_v))/Z3} \\
& - \frac{(exp(-Z3 - Y.*Z3)*S^2.*Y.^2*(S_v))/Z3 - (3*S^2*Z3*(S_v))/(4*exp(4*Z3))}{(7*S^2*Z3*(S_v))/(4*exp(2*Z3)) - (3*S^2*Z3*(S_v))/(4*exp(4*Z3)) - (3*S^2*Z3*(S_v))/(4*exp(2*Z3))} \\
& + \frac{(2*S.*Y.*Z3*(S_v))/exp(2*Z3) + (S^2.*Y.*Z3*(S_v))/exp(2*Z3) + (S.*Y.^2*Z3*(S_v))/exp(3*Z3) + (3*S.*Y.^2*Z3*(S_v))/(2*exp(2*Z3)) + (S^2.*Y.^2*Z3*(S_v))/exp(3*Z3)}{(S^2.*Y.^2*Z3*(S_v))/exp(2*Z3) + (S^2.*Y.^2*Z3*(S_v))/(4*exp(4*Z3))} \\
& + \frac{(S.*Y.^4*Z3*(S_v))/exp(3*Z3) - (S.*Y.^4*Z3*(S_v))/(4*exp(2*Z3))}{(S^2.*Y.^4*Z3*(S_v))/exp(3*Z3) + (S^2.*Y.^4*Z3*(S_v))/(4*exp(2*Z3))} \\
& + \frac{(S^2.*Y.^4*Z3*(S_v))/(2*exp(3*Z3)) - (S.*Y.^2*Z3^2*(S_v))/exp(3*Z3)}{(S^2.*Y.^2*Z3^2*(S_v))/(2*exp(3*Z3)) + (S.*Y.^4*Z3^2*(S_v))/exp(3*Z3)} \\
& + \frac{(S^2.*Y.^2*Z3^2*(S_v))/(2*exp(3*Z3)) + (S.*Y.^4*Z3^2*(S_v))/(2*exp(3*Z3))}{(S^2.*Y.^4*Z3^2*(S_v))/(2*exp(3*Z3))} \\
& + \frac{(S^2.*Y.^4*Z3^2*(S_v))/(2*exp(3*Z3)) - (9*S^2*(S_v)^2)/(16*exp(6*Z3))}{(23*S^2*(S_v)^2)/(8*exp(4*Z3)) + (2*S^2*(S_v)^2)/exp(3*Z3) + (S^2*(S_v)^2)/(16*exp(2*Z3))} \\
& - \frac{(exp(-2*Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/2 - exp(-3*Z3 - Y.*Z3)*S^2*(S_v)^2}{(2*S^2.*Y.^(S_v)^2)/exp(3*Z3) - (S^2.*Y.^(S_v)^2)/exp(2*Z3) + (9*S^2.*Y.^2*(S_v)^2)/(8*exp(6*Z3))} \\
& \dots \\
& - \frac{(3*S^2.*Y.^2*(S_v)^2)/(2*exp(5*Z3)) + (11*S^2.*Y.^2*(S_v)^2)/(2*exp(4*Z3))}{(7*S^2.*Y.^2*(S_v)^2)/(2*exp(3*Z3)) + (15*S^2.*Y.^2*(S_v)^2)/(8*exp(2*Z3))} \\
& + \frac{(exp(-2*Z3 - 2.*Y.*Z3)*S^2.*Y.^2*(S_v)^2)/2 + exp(-3*Z3 - Y.*Z3)*S^2.*Y.^2*(S_v)^2}{(3*S^2.*Y.^3*(S_v)^2)/exp(4*Z3) + (4*S^2.*Y.^3*(S_v)^2)/exp(3*Z3)} \\
& - \frac{(S^2.*Y.^3*(S_v)^2)/exp(2*Z3) + (9*S^2.*Y.^4*(S_v)^2)/(16*exp(6*Z3))}{(3*S^2.*Y.^4*(S_v)^2)/(2*exp(5*Z3)) + (11*S^2.*Y.^4*(S_v)^2)/(8*exp(4*Z3))} \\
& - \frac{(S^2.*Y.^4*(S_v)^2)/(2*exp(3*Z3)) + (S^2.*Y.^4*(S_v)^2)/(16*exp(2*Z3))}{(9*S^2*(S_v)^2)/(4*exp(6*Z3)*Z3^4) - (6*S^2*(S_v)^2)/(exp(5*Z3)*Z3^4)} \\
& + \frac{(11*S^2*(S_v)^2)/(2*exp(4*Z3)*Z3^4) - (2*S^2*(S_v)^2)/(exp(3*Z3)*Z3^4)}{(S^2*(S_v)^2)/(4*exp(2*Z3)*Z3^4) + (S^2*(S_v)^2)/(4*exp(2.*Y.*Z3)*Z3^4)} \\
& + \frac{(9*exp(-4*Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/(4*Z3^4) - (6*exp(-3*Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/Z3^4 + (11*exp(-2*Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/(2*Z3^4)}{(2*exp(-Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/Z3^4 - (9*exp(-5*Z3 - Y.*Z3)*S^2*(S_v)^2)/(2*Z3^4) + (12*exp(-4*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3^4 - (11*exp(-3*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3^4} \\
& + \frac{(4*exp(-2*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3^4 - (exp(-Z3 - Y.*Z3)*S^2*(S_v)^2)/(2*Z3^4) + (12*S^2*(S_v)^2)/(exp(5*Z3)*Z3^3) - (22*S^2*(S_v)^2)/(exp(4*Z3)*Z3^3)}{(27*S^2*(S_v)^2)/(2*exp(3*Z3)*Z3^3) - (4*S^2*(S_v)^2)/(exp(2*Z3)*Z3^3)} \\
& + \frac{(S^2*(S_v)^2)/(2*exp(3*Z3)*Z3^3) - (S^2*(S_v)^2)/(2*exp(3.*Y.*Z3)*Z3^3)}{(S^2*(S_v)^2)/(2*exp(Y.*Z3)*Z3^3) - (3*exp(-2*Z3 - 3.*Y.*Z3)*S^2*(S_v)^2)/(2*Z3^3) + (2*exp(-Z3 - 3.*Y.*Z3)*S^2*(S_v)^2)/Z3^3 - (3*exp(-3*Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/(2*Z3^3)} \\
& + \frac{(2*exp(-2*Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/Z3^3 - (exp(-Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/(2*Z3^3) - (9*exp(-4*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3^3 + (18*exp(-3*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3^3}{(9*exp(-4*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3^3}
\end{aligned}$$

$$\begin{aligned}
& - (25*\exp(-2*Z3 - Y.*Z3)*S^2*(S_v)^2)/(2*Z3^3) + (4*\exp(-Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3^3 - \\
& (9*S^2.*Y.^(S_v)^2)/(2*\exp(5*Z3)*Z3^3) + (12*S^2.*Y.^(S_v)^2)/(\exp(4*Z3)*Z3^3) ... \\
& - (11*S^2.*Y.^(S_v)^2)/(exp(3*Z3)*Z3^3) + (4*S^2.*Y.^(S_v)^2)/(exp(2*Z3)*Z3^3) - \\
& (S^2.*Y.^(S_v)^2)/(2*\exp(Z3)*Z3^3) + (S^2.*Y.^(S_v)^2)/(2*\exp(Y.*Z3)*Z3^3) ... \\
& + (9*\exp(-4*Z3 - Y.*Z3)*S^2.*Y.^(S_v)^2)/(2*Z3^3) - (12*\exp(-3*Z3 - Y.*Z3)*S^2.*Y.^(S_v)^2)/Z3^3 ... \\
& - (4*\exp(-Z3 - Y.*Z3)*S^2.*Y.^(S_v)^2)/Z3^3 + (S^2*(S_v)^2)/(4*Z3^2) + \\
& (9*S^2*(S_v)^2)/(4*\exp(6*Z3)*Z3^2) - (3*S^2*(S_v)^2)/(exp(5*Z3)*Z3^2) + \\
& (19*S^2*(S_v)^2)/(exp(4*Z3)*Z3^2) ... \\
& - (19*S^2*(S_v)^2)/(exp(3*Z3)*Z3^2) + (35*S^2*(S_v)^2)/(4*\exp(2*Z3)*Z3^2) - \\
& (2*S^2*(S_v)^2)/(exp(Z3)*Z3^2) + (S^2*(S_v)^2)/(4*\exp(4.*Y.*Z3)*Z3^2) ... \\
& + (S^2*(S_v)^2)/(2*\exp(2.*Y.*Z3)*Z3^2) + (\exp(-Z3 - 3.*Y.*Z3)*S^2*(S_v)^2)/Z3^2 + (5*\exp(-2*Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/Z3^2 - (2*\exp(-Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/Z3^2 ... \\
& - (9*\exp(-5*Z3 - Y.*Z3)*S^2*(S_v)^2)/(4*Z3^2) + (3*\exp(-4*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3^2 + \\
& (5*\exp(-3*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3^2 - (\exp(-2*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3^2 ... \\
& + (\exp(-Z3 - Y.*Z3)*S^2*(S_v)^2)/(4*Z3^2) - (S^2.*Y.^(S_v)^2)/(2*Z3^2) - \\
& (15*S^2.*Y.^(S_v)^2)/(exp(4*Z3)*Z3^2) + (26*S^2.*Y.^(S_v)^2)/(exp(3*Z3)*Z3^2) ... \\
& - (29*S^2.*Y.^(S_v)^2)/(2*\exp(2*Z3)*Z3^2) + (4*S^2.*Y.^(S_v)^2)/(exp(Z3)*Z3^2) - \\
& (S^2.*Y.^(S_v)^2)/(2*\exp(2.*Y.*Z3)*Z3^2) - (3*\exp(-2*Z3 - 2.*Y.*Z3)*S^2.*Y.^(S_v)^2)/(2*Z3^2) ... \\
& + (2*\exp(-Z3 - 2.*Y.*Z3)*S^2.*Y.^(S_v)^2)/(Z3^2) + (S^2.*Y.^2*(S_v)^2)/(4*Z3^2) + \\
& (9*S^2.*Y.^2*(S_v)^2)/(4*\exp(6*Z3)*Z3^2) - (6*S^2.*Y.^2*(S_v)^2)/(exp(5*Z3)*Z3^2) ... \\
& + (31*S^2.*Y.^2*(S_v)^2)/(4*\exp(4*Z3)*Z3^2) - (8*S^2.*Y.^2*(S_v)^2)/(exp(3*Z3)*Z3^2) + \\
& (23*S^2.*Y.^2*(S_v)^2)/(4*\exp(2*Z3)*Z3^2) - (2*S^2.*Y.^2*(S_v)^2)/(exp(Z3)*Z3^2) ... \\
& - (9*\exp(-5*Z3 - Y.*Z3)*S^2.*Y.^2*(S_v)^2)/(4*Z3^2) + (6*\exp(-4*Z3 - Y.*Z3)*S^2.*Y.^2*(S_v)^2)/Z3^2 - (11*\exp(-3*Z3 - Y.*Z3)*S^2.*Y.^2*(S_v)^2)/(2*Z3^2) ... \\
& + (2*\exp(-2*Z3 - Y.*Z3)*S^2.*Y.^2*(S_v)^2)/(Z3^2) - (\exp(-Z3 - Y.*Z3)*S^2.*Y.^2*(S_v)^2)/(4*Z3^2) + \\
& (9*S^2*(S_v)^2)/(2*\exp(5*Z3)*Z3) - (S^2*(S_v)^2)/(exp(4*Z3)*Z3) ... \\
& + (25*S^2*(S_v)^2)/(4*\exp(3*Z3)*Z3) - (3*S^2*(S_v)^2)/(exp(2*Z3)*Z3) + \\
& (3*S^2*(S_v)^2)/(4*\exp(Z3)*Z3) + (3*\exp(-3*Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/(4*Z3) ... \\
& + (3*\exp(-Z3 - 2.*Y.*Z3)*S^2*(S_v)^2)/(4*Z3) + (3*\exp(-4*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3 - (2*\exp(-3*Z3 - Y.*Z3)*S^2*(S_v)^2)/Z3 + (2*\exp(-2*Z3 - Y.*Z3)*S^2*(S_v)^2)/(Z3^2) ... \\
& - (9*S^2.*Y.^(S_v)^2)/(4*\exp(5*Z3)*Z3) + (3*S^2.*Y.^(S_v)^2)/(exp(4*Z3)*Z3) - \\
& (11*S^2.*Y.^(S_v)^2)/(exp(3*Z3)*Z3) + (7*S^2.*Y.^(S_v)^2)/(exp(2*Z3)*Z3) ... \\
& - (7*S^2.*Y.^(S_v)^2)/(4*\exp(Z3)*Z3) - (\exp(-Z3 - 2.*Y.*Z3)*S^2.*Y.^(S_v)^2)/Z3 - (2*\exp(-2*Z3 - Y.*Z3)*S^2.*Y.^(S_v)^2)/Z3 + (15*S^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z3)*Z3) ... \\
& - (13*S^2.*Y.^2*(S_v)^2)/(exp(4*Z3)*Z3) + (41*S^2.*Y.^2*(S_v)^2)/(4*\exp(3*Z3)*Z3) - \\
& (6*S^2.*Y.^2*(S_v)^2)/(exp(2*Z3)*Z3) + (5*S^2.*Y.^2*(S_v)^2)/(4*\exp(Z3)*Z3) ... \\
& + (3*\exp(-3*Z3 - 2.*Y.*Z3)*S^2.*Y.^2*(S_v)^2)/(4*Z3) - (\exp(-2*Z3 - 2.*Y.*Z3)*S^2.*Y.^2*(S_v)^2)/Z3 + (exp(-3*Z3 - 2.*Y.*Z3)*S^2.*Y.^2*(S_v)^2)/(4*Z3) ... \\
& - (9*S^2.*Y.^3*(S_v)^2)/(4*\exp(5*Z3)*Z3) + (6*S^2.*Y.^3*(S_v)^2)/(exp(4*Z3)*Z3) - \\
& (11*S^2.*Y.^3*(S_v)^2)/(2*\exp(3*Z3)*Z3) + (2*S^2.*Y.^3*(S_v)^2)/(exp(2*Z3)*Z3) ... \\
& - (S^2.*Y.^3*(S_v)^2)/(4*\exp(Z3)*Z3) - (3*S^2*Z3*(S_v)^2)/(4*\exp(5*Z3)) - \\
& (3*S^2*Z3*(S_v)^2)/(4*\exp(3*Z3)) + (S^2.*Y.*Z3*(S_v)^2)/(exp(3*Z3)) + \\
& (S^2.*Y.^2*Z3*(S_v)^2)/(exp(4*Z3)) ... \\
& + (S^2.*Y.^2*Z3*(S_v)^2)/(2*\exp(3*Z3)) - (S^2.*Y.^3*Z3*(S_v)^2)/(exp(3*Z3)) + \\
& (3*S^2.*Y.^4*Z3*(S_v)^2)/(4*\exp(5*Z3)) - (S^2.*Y.^4*Z3*(S_v)^2)/(exp(4*Z3)) ... \\
& + (S^2.*Y.^4*Z3*(S_v)^2)/(4*\exp(3*Z3)) + (S^2*Z3^2*(S_v)^2)/(4*\exp(4*Z3)) - \\
& (S^2.*Y.^2*Z3^2*(S_v)^2)/(2*\exp(4*Z3)) + (S^2.*Y.^4*Z3^2*(S_v)^2)/(4*\exp(4*Z3)); 
\end{aligned}$$

Ns3=Nf3+Nc+Ny3;  
 Phi3=Nf3./[Nc+Ny3];  
 Be3=1./[1+Phi3];  
 Gf3=Nf3./Ns3;  
 Gh3=[Nc+Ny3]./Ns3;  
 Nh3=Nc+Ny3;

Z4=12.5;

$$\begin{aligned}
& \text{Nf4} = \text{Br}^*[(Z4^2).*\exp(-2.*Y.*Z4)+(Z4^2)*\exp(-2*Z4)-2*Z4^2.*\exp(-Z4-Y.*Z4)]; \\
& \text{Ny4}=1 - \exp(-2*Z4) + \exp(-Z4 - Y.*Z4) - (2*S)/\exp(2*Z4) + 2*\exp(-Z4 - Y.*Z4)*S - S^2/\exp(2*Z4) + \\
& \exp(-Z4 - Y.*Z4)*S^2 - 2.*Y + Y.^2 + Y.^2/\exp(2*Z4) - \exp(-Z4 - Y.*Z4).*Y.^2 ... \\
& \quad + (2*S.*Y.^2)/\exp(2*Z4) - 2*\exp(-Z4 - Y.*Z4)*S.*Y.^2 + (S^2.*Y.^2)/\exp(2*Z4) - \exp(-Z4 - \\
& Y.*Z4)*S^2.*Y.^2 + 1/(\exp(2*Z4)*Z4^2) + 1./(\exp(2.*Y.*Z4)*Z4^2) ... \\
& \quad - (2*\exp(-Z4 - Y.*Z4))/Z4^2 + (2*S)/(\exp(2*Z4)*Z4^2) + (2*S)./(\exp(2.*Y.*Z4)*Z4^2) - (4*\exp(-Z4 - \\
& Y.*Z4)*S)/Z4^2 + S^2/(\exp(2*Z4)*Z4^2) + S^2./(\exp(2.*Y.*Z4)*Z4^2) ... \\
& \quad - (2*\exp(-Z4 - Y.*Z4)*S^2)/Z4^2 + 2/(\exp(Z4)*Z4) - 2./(\exp(Y.*Z4)*Z4) + (2*S)/(\exp(Z4)*Z4) - \\
& (2*S)./(\exp(Y.*Z4)*Z4) - (2.*Y)/(\exp(Z4)*Z4) + (2.*Y)/(\exp(Y.*Z4)*Z4) ... \\
& \quad - (2*S.*Y)/(\exp(Z4)*Z4) + (2*S.*Y)/(\exp(Y.*Z4)*Z4) - Z4/\exp(Z4) - (S*Z4)/\exp(Z4) + \\
& (Y.*Z4)/\exp(Z4) + (S.*Y.*Z4)/\exp(Z4) + (Y.^2*Z4)/\exp(Z4) + (S.*Y.^2*Z4)/\exp(Z4) - (Y.^3*Z4)/\exp(Z4) \\
& ... \\
& \quad - (S.*Y.^3*Z4)/\exp(Z4) + Z4^2/(4*\exp(2*Z4)) + (S*Z4^2)/(2*\exp(2*Z4)) + (S^2*Z4^2)/(4*\exp(2*Z4)) \\
& - (Y.^2*Z4^2)/(2*\exp(2*Z4)) - (S.*Y.^2*Z4^2)/\exp(2*Z4) ... \\
& \quad - (S^2.*Y.^2*Z4^2)/(2*\exp(2*Z4)) + (Y.^4*Z4^2)/(4*\exp(2*Z4)) + (S.*Y.^4*Z4^2)/(2*\exp(2*Z4)) + \\
& (S^2.*Y.^4*Z4^2)/(4*\exp(2*Z4)) - (7*S*(S_v))/(2*\exp(3*Z4)) ... \\
& \quad + (2*S*(S_v))/\exp(2*Z4) + (S*(S_v))/\exp(Z4) - (\exp(-Z4 - 2.*Y.*Z4)*S*(S_v))/2 - \\
& (5*S^2*(S_v))/\exp(3*Z4) + (2*S^2*(S_v))/\exp(2*Z4) - (S^2*(S_v))/(2*\exp(Z4)) ... \\
& \quad - (\exp(-Z4 - 2.*Y.*Z4)*S^2*(S_v))/2 - (2*S.*Y.(S_v))/\exp(2*Z4) - (3*S.*Y.(S_v))/\exp(Z4) + \\
& (3*S^2.*Y.(S_v))/(2*\exp(3*Z4)) - (2*S^2.*Y.(S_v))/\exp(2*Z4) ... \\
& \quad + (S^2.*Y.(S_v))/(2*\exp(Z4)) + (13*S.*Y.^2*(S_v))/(2*\exp(3*Z4)) - (4*S.*Y.^2*(S_v))/\exp(2*Z4) + \\
& (3*S.*Y.^2*(S_v))/\exp(Z4) + (\exp(-Z4 - 2.*Y.*Z4)*S.*Y.^2*(S_v))/2 ... \\
& \quad + (5*S^2.*Y.^2*(S_v))/\exp(3*Z4) - (2*S^2.*Y.^2*(S_v))/\exp(2*Z4) + (S^2.*Y.^2*(S_v))/(2*\exp(Z4)) \\
& + (\exp(-Z4 - 2.*Y.*Z4)*S^2.*Y.^2*(S_v))/2 - (3*S.*Y.^3*(S_v))/\exp(3*Z4) ... \\
& \quad + (4*S.*Y.^3*(S_v))/\exp(2*Z4) - (S.*Y.^3*(S_v))/\exp(Z4) - (3*S^2.*Y.^3*(S_v))/(2*\exp(3*Z4)) + \\
& (2*S^2.*Y.^3*(S_v))/\exp(2*Z4) - (S^2.*Y.^3*(S_v))/(2*\exp(Z4)) ... \\
& \quad + (3*S*(S_v))/(4*\exp(2*Z4)*Z4^3) - (4*S*(S_v))/(\exp(3*Z4)*Z4^3) + (S*(S_v))/(\exp(2*Z4)*Z4^3) + \\
& (S*(S_v))./(\exp(2.*Y.*Z4)*Z4^3) + (3*\exp(-2*Z4 - 2.*Y.*Z4)*S*(S_v))/Z4^3 ... \\
& \quad - (4*\exp(-Z4 - 2.*Y.*Z4)*S*(S_v))/Z4^3 - (6*\exp(-3*Z4 - Y.*Z4)*S*(S_v))/Z4^3 + (8*\exp(-2*Z4 - \\
& Y.*Z4)*S*(S_v))/Z4^3 - (2*\exp(-Z4 - Y.*Z4)*S*(S_v))/Z4^3 ... \\
& \quad + (3*S^2*(S_v))/(4*\exp(2*Z4)*Z4^3) - (4*S^2*(S_v))/(\exp(3*Z4)*Z4^3) + \\
& (S^2*(S_v))./(\exp(2*Z4)*Z4^3) + (S^2*(S_v))./(\exp(2.*Y.*Z4)*Z4^3) + (3*\exp(-2*Z4 - \\
& 2.*Y.*Z4)*S^2*(S_v))/Z4^3 ... \\
& \quad - (4*\exp(-Z4 - 2.*Y.*Z4)*S^2*(S_v))/Z4^3 - (6*\exp(-3*Z4 - Y.*Z4)*S^2*(S_v))/Z4^3 + (8*\exp(-2*Z4 - \\
& Y.*Z4)*S^2*(S_v))/Z4^3 - (2*\exp(-Z4 - Y.*Z4)*S^2*(S_v))/Z4^3 ... \\
& \quad + (11*S*(S_v))/(4*\exp(2*Z4)*Z4^2) - (8*S*(S_v))/(\exp(2*Z4)*Z4^2) + (2*S*(S_v))/(\exp(Z4)*Z4^2) - \\
& (S*(S_v))./(\exp(3.*Y.*Z4)*Z4^2) - (2*S*(S_v))./(\exp(Y.*Z4)*Z4^2) ... \\
& \quad - (\exp(-Z4 - 2.*Y.*Z4)*S*(S_v))/Z4^2 - (9*\exp(-2*Z4 - Y.*Z4)*S*(S_v))/Z4^2 + (8*\exp(-Z4 - \\
& Y.*Z4)*S*(S_v))/Z4^2 + (8*S^2*(S_v))/(\exp(3*Z4)*Z4^2); ... \\
& \quad - (4*S^2*(S_v))/(\exp(2*Z4)*Z4^2) + (S^2*(S_v))/(\exp(Z4)*Z4^2) - \\
& (S^2*(S_v))./(\exp(3.*Y.*Z4)*Z4^2) - (S^2*(S_v))./(\exp(Y.*Z4)*Z4^2) - (\exp(-Z4 - \\
& 2.*Y.*Z4)*S^2*(S_v))/Z4^2 ... \\
& \quad - (6*\exp(-2*Z4 - Y.*Z4)*S^2*(S_v))/Z4^2 + (4*\exp(-Z4 - Y.*Z4)*S^2*(S_v))/Z4^2 - \\
& (6*S.*Y.(S_v))/(\exp(3*Z4)*Z4^2) + (8*S.*Y.(S_v))/(\exp(2*Z4)*Z4^2) ... \\
& \quad - (2*S.*Y.(S_v))/(\exp(Z4)*Z4^2) + (2*S.*Y.(S_v))/(\exp(Y.*Z4)*Z4^2) + (6*\exp(-2*Z4 - \\
& Y.*Z4)*S.*Y.(S_v))/Z4^2 - (8*\exp(-Z4 - Y.*Z4)*S.*Y.(S_v))/Z4^2 ... \\
& \quad - (3*S^2.*Y.(S_v))/(\exp(3*Z4)*Z4^2) + (4*S^2.*Y.(S_v))/(\exp(2*Z4)*Z4^2) - \\
& (S^2.*Y.(S_v))/(\exp(Z4)*Z4^2) + (S^2.*Y.(S_v))/(\exp(Y.*Z4)*Z4^2) ... \\
& \quad + (3*\exp(-2*Z4 - Y.*Z4)*S^2.*Y.(S_v))/Z4^2 - (4*\exp(-Z4 - Y.*Z4)*S^2.*Y.(S_v))/Z4^2 + \\
& (S*(S_v))/Z4 + (2*S*(S_v))/(\exp(3*Z4)*Z4) + (9*S*(S_v))/(\exp(2*Z4)*Z4) ... \\
& \quad - (4*S*(S_v))/(\exp(Z4)*Z4) + (S*(S_v))./(\exp(2.*Y.*Z4)*Z4) - (2*\exp(-2*Z4 - Y.*Z4)*S*(S_v))/Z4 + \\
& (\exp(-Z4 - Y.*Z4)*S*(S_v))/Z4 + (2*S^2*(S_v))/(\exp(3*Z4)*Z4) ... \\
& \quad + (S^2*(S_v))/(\exp(2*Z4)*Z4) - (2*\exp(-2*Z4 - Y.*Z4)*S^2*(S_v))/Z4 - (\exp(-Z4 - \\
& Y.*Z4)*S^2*(S_v))/Z4 - (2*S.*Y.(S_v))/Z4 - (13*S.*Y.(S_v))/(\exp(2*Z4)*Z4) ...
\end{aligned}$$

$$\begin{aligned}
& + \frac{(8*S.*Y.*(S_v))/(exp(Z4)*Z4)}{(S.*Y.*(S_v))./(exp(2.*Y.*Z4)*Z4)} - \\
& (2*S^2.*Y.*(S_v))/(exp(2*Z4)*Z4) + \frac{(2*exp(-Z4 - Y.*Z4)*S^2.*Y.*(S_v))/Z4 + (S.*Y.^2*(S_v))/Z4}{...} \\
& + \frac{(3*S.*Y.^2*(S_v))/(exp(4*Z4)*Z4)}{(4*S.*Y.^2*(S_v))/(exp(2*Z4)*Z4)} - \frac{(4*S.*Y.^2*(S_v))/(exp(3*Z4)*Z4)}{(4*S.*Y.^2*(S_v))/(exp(2*Z4)*Z4)} + \\
& (4*S.*Y.^2*(S_v))/(exp(2*Z4)*Z4) - \frac{(4*S.*Y.^2*(S_v))/(exp(3*Z4)*Z4)}{(4*S.*Y.^2*(S_v))/(exp(2*Z4)*Z4)} ... \\
& - \frac{(3*exp(-3*Z4 - Y.*Z4)*S.*Y.^2*(S_v))/Z4 + (4*exp(-2*Z4 - Y.*Z4)*S.*Y.^2*(S_v))/Z4 - (exp(-Z4 - Y.*Z4)*S.*Y.^2*(S_v))/Z4 + (3*S^2.*Y.^2*(S_v))/(exp(4*Z4)*Z4)}{(3*exp(-3*Z4 - Y.*Z4)*S.*Y.^2*(S_v))/Z4 - (4*S.^2.*Y.^2*(S_v))/(exp(3*Z4)*Z4) ...} \\
& - \frac{(4*S.^2.*Y.^2*(S_v))/(exp(3*Z4)*Z4) + (S^2.*Y.^2*(S_v))/(exp(2*Z4)) - (3*exp(-3*Z4 - Y.*Z4)*S.^2.*Y.^2*(S_v))/Z4 + (4*exp(-2*Z4 - Y.*Z4)*S.^2.*Y.^2*(S_v))/Z4 ...} \\
& - \frac{(exp(-Z4) - Y.*Z4)*S^2.*Y.^2*(S_v))/Z4 - (3*S*Z4*(S_v))/(4*exp(4*Z4))}{(exp(-Z4) - Y.*Z4)*S^2.*Y.^2*(S_v))/Z4 + (4*S.^2.*Y.^2*(S_v))/(exp(3*Z4)*Z4) ...} \\
& (7*S*Z4*(S_v))/(4*exp(2*Z4)) - \frac{(3*S^2*Z4*(S_v))/(4*exp(4*Z4)) - (3*S^2*Z4*(S_v))/(4*exp(2*Z4)) ...}{(2*S.*Y.*Z4*(S_v))/(exp(2*Z4)) + (S^2.*Y.*Z4*(S_v))/(exp(2*Z4)) + (S.*Y.^2*Z4*(S_v))/(exp(3*Z4) + (3*S.*Y.^2*Z4*(S_v))/(2*exp(2*Z4)) + (S^2.*Y.^2*Z4*(S_v))/(exp(3*Z4) ...} \\
& + \frac{(S^2.*Y.^2*Z4*(S_v))/(2*exp(2*Z4))}{(S^2.*Y.^3*Z4*(S_v))/(exp(2*Z4))} - \frac{(2*S.*Y.^3*Z4*(S_v))/(exp(2*Z4))}{(3*S.*Y.^4*Z4*(S_v))/(4*exp(4*Z4))} - \\
& (S.*Y.^4*Z4*(S_v))/(exp(3*Z4) ...} \\
& + \frac{(S.*Y.^4*Z4*(S_v))/(4*exp(2*Z4))}{(S.^2.*Y.^4*Z4*(S_v))/(exp(3*Z4))} + \frac{(3*S^2.*Y.^4*Z4*(S_v))/(4*exp(4*Z4))}{(S.^2.*Y.^4*Z4*(S_v))/(4*exp(2*Z4))} + \\
& (S*Z4^2*(S_v))/(2*exp(3*Z4)) ...} \\
& + \frac{(S^2*Z4^2*(S_v))/(2*exp(3*Z4))}{(S.^2.*Y.^2*Z4^2*(S_v))/(exp(3*Z4))} - \frac{(S.*Y.^2*Z4^2*(S_v))/(exp(3*Z4))}{(S.^2.*Y.^2*Z4^2*(S_v))/(exp(3*Z4) ...} \\
& + \frac{(S^2.*Y.^4*Z4^2*(S_v))/(2*exp(3*Z4))}{(S^2.*Y.^4*Z4^2*(S_v))/(exp(3*Z4))} + \frac{(9*S^2*(S_v)^2)/(16*exp(6*Z4))}{(23*S^2*(S_v)^2)/(8*exp(4*Z4)) + (2*S^2*(S_v)^2)/(exp(3*Z4)) + (S^2*(S_v)^2)/(16*exp(2*Z4)) ...} \\
& - \frac{(exp(-2*Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/2}{(2*S^2.*Y.(S_v)^2)/(exp(3*Z4) - (S^2.*Y.(S_v)^2)/(exp(2*Z4) + (9*S^2.*Y.^2*(S_v)^2)/(8*exp(6*Z4)))} \\
& ...} \\
& - \frac{(3*S^2.*Y.^2*(S_v)^2)/(2*exp(5*Z4))}{(7*S^2.*Y.^2*(S_v)^2)/(2*exp(3*Z4)) + (15*S^2.*Y.^2*(S_v)^2)/(8*exp(2*Z4)) ...} \\
& + \frac{(exp(-2*Z4 - 2.*Y.*Z4)*S^2.*Y.^2*(S_v)^2)/2}{(3*S^2.*Y.^3*(S_v)^2)/(exp(4*Z4) + (4*S^2.*Y.^3*(S_v)^2)/(exp(3*Z4) ...} \\
& - \frac{(S^2.*Y.^3*(S_v)^2)/(exp(2*Z4))}{(3*S^2.*Y.^4*(S_v)^2)/(2*exp(5*Z4)) + (11*S^2.*Y.^4*(S_v)^2)/(8*exp(4*Z4)) ...} \\
& - \frac{(S^2.*Y.^4*(S_v)^2)/(2*exp(3*Z4))}{(9*S^2*(S_v)^2)/(4*exp(6*Z4)*Z4^4) - (6*S^2*(S_v)^2)/(exp(5*Z4)*Z4^4) ...} \\
& + \frac{(11*S^2*(S_v)^2)/(2*exp(4*Z4)*Z4^4)}{(S^2*(S_v)^2)/(4*exp(2*Z4)*Z4^4) + (S^2*(S_v)^2)/(4*exp(2.*Y.*Z4)*Z4^4) ...} \\
& + \frac{(9*exp(-4*Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/(4*Z4^4) - (6*exp(-3*Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/Z4^4 + (11*exp(-2*Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/(2*Z4^4) ...} \\
& - \frac{(2*exp(-Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/Z4^4 - (9*exp(-5*Z4 - Y.*Z4)*S^2*(S_v)^2)/(2*Z4^4) + (12*exp(-4*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4^4 - (11*exp(-3*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4^4 ...} \\
& + \frac{(4*exp(-2*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4^4 - (exp(-Z4 - Y.*Z4)*S^2*(S_v)^2)/(2*Z4^4) + (12*S^2*(S_v)^2)/(exp(5*Z4)*Z4^3) - (22*S^2*(S_v)^2)/(exp(4*Z4)*Z4^3) ...} \\
& + \frac{(27*S^2*(S_v)^2)/(2*exp(3*Z4)*Z4^3) - (4*S^2*(S_v)^2)/(exp(2*Z4)*Z4^3)}{(S^2*(S_v)^2)/(2*exp(Z4)*Z4^3) - (S^2*(S_v)^2)/(2*exp(3.*Y.*Z4)*Z4^3) ...} \\
& - \frac{(S^2*(S_v)^2)/(2*exp(Y.*Z4)*Z4^3) - (3*exp(-2*Z4 - 3.*Y.*Z4)*S^2*(S_v)^2)/(2*Z4^3) + (2*exp(-Z4 - 3.*Y.*Z4)*S^2*(S_v)^2)/Z4^3 - (3*exp(-3*Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/(2*Z4^3) ...} \\
& + \frac{(2*exp(-2*Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/Z4^3 - (exp(-Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/(2*Z4^3) - (9*exp(-4*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4^3 + (18*exp(-3*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4^3 ...} \\
& - \frac{(25*exp(-2*Z4 - Y.*Z4)*S^2*(S_v)^2)/(2*Z4^3) + (4*exp(-Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4^3 - (9*S^2.*Y.(S_v)^2)/(2*exp(5*Z4)*Z4^3) + (12*S^2.*Y.(S_v)^2)/(exp(4*Z4)*Z4^3) ...} \\
& - \frac{(11*S^2.*Y.(S_v)^2)/(exp(3*Z4)*Z4^3) + (4*S^2.*Y.(S_v)^2)/(exp(2*Z4)*Z4^3)}{(S^2.*Y.(S_v)^2)/(2*exp(Z4)*Z4^3) + (S^2.*Y.(S_v)^2)/(2*exp(Y.*Z4)*Z4^3) ...} \\
& + \frac{(9*exp(-4*Z4 - Y.*Z4)*S^2.*Y.(S_v)^2)/(2*Z4^3) - (12*exp(-3*Z4 - Y.*Z4)*S^2.*Y.(S_v)^2)/Z4^3 + (11*exp(-2*Z4 - Y.*Z4)*S^2.*Y.(S_v)^2)/Z4^3 ...} \\
& - \frac{(4*exp(-Z4 - Y.*Z4)*S^2.*Y.(S_v)^2)/Z4^3 + (S^2*(S_v)^2)/(4*Z4^2)}{(9*S^2*(S_v)^2)/(4*exp(6*Z4)*Z4^2) - (3*S^2*(S_v)^2)/(exp(5*Z4)*Z4^2) + (19*S^2*(S_v)^2)/(exp(4*Z4)*Z4^2) ...}
\end{aligned}$$

$$\begin{aligned}
& - \frac{(19*S^2*(S_v)^2)/(exp(3*Z4)*Z4^2)}{(2*S^2*(S_v)^2)/(exp(Z4)*Z4^2) + (S^2*(S_v)^2)./(4*exp(4.*Y.*Z4)*Z4^2)} + \frac{(35*S^2*(S_v)^2)/(4*exp(2*Z4)*Z4^2)}{(2*exp(-2*Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/Z4^2 + (5*exp(-2*Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/Z4^2} \\
& - \frac{(9*exp(-5*Z4 - Y.*Z4)*S^2*(S_v)^2)/(4*Z4^2)}{(9*exp(-5*Z4 - Y.*Z4)*S^2*(S_v)^2)/(4*Z4^2) + (3*exp(-4*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4^2 + (5*exp(-3*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4^2 - (exp(-2*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4^2} \\
& + \frac{(exp(-Z4 - Y.*Z4)*S^2*(S_v)^2)/(4*Z4^2)}{(exp(-Z4 - Y.*Z4)*S^2*(S_v)^2)/(4*Z4^2) - (S^2.*Y.(S_v)^2)/(2*Z4^2)} \\
& (15*S^2.*Y.(S_v)^2)/(exp(4*Z4)*Z4^2) + (26*S^2.*Y.(S_v)^2)/(exp(3*Z4)*Z4^2) \\
& - \frac{(29*S^2.*Y.(S_v)^2)/(2*exp(2*Z4)*Z4^2)}{(S^2.*Y.(S_v)^2)./(2*exp(2.*Y.*Z4)*Z4^2) - (3*exp(-2*Z4 - 2.*Y.*Z4)*S^2.*Y.(S_v)^2)/(2*Z4^2)} \\
& + \frac{(2*exp(-Z4 - 2.*Y.*Z4)*S^2.*Y.(S_v)^2)/Z4^2}{(2*exp(-Z4 - 2.*Y.*Z4)*S^2.*Y.(S_v)^2)/Z4^2 + (S^2.*Y.^2*(S_v)^2)/(4*Z4^2)} \\
& (9*S^2.*Y.^2*(S_v)^2)/(4*exp(6*Z4)*Z4^2) - (6*S^2.*Y.^2*(S_v)^2)/(exp(5*Z4)*Z4^2) \\
& + \frac{(31*S^2.*Y.^2*(S_v)^2)/(4*exp(4*Z4)*Z4^2)}{(9*S^2.*Y.^2*(S_v)^2)/(4*exp(6*Z4)*Z4^2) - (6*S^2.*Y.^2*(S_v)^2)/(exp(5*Z4)*Z4^2)} \\
& (23*S^2.*Y.^2*(S_v)^2)/(4*exp(2*Z4)*Z4^2) - (2*S^2.*Y.^2*(S_v)^2)/(exp(Z4)*Z4^2) \\
& - \frac{(9*exp(-5*Z4 - Y.*Z4)*S^2.*Y.^2*(S_v)^2)/(4*Z4^2)}{(9*exp(-5*Z4 - Y.*Z4)*S^2.*Y.^2*(S_v)^2)/(4*Z4^2) + (6*exp(-4*Z4 - Y.*Z4)*S^2.*Y.^2*(S_v)^2)/Z4^2} \\
& + (2*exp(-2*Z4 - Y.*Z4)*S^2.*Y.^2*(S_v)^2)/Z4^2 - (exp(-Z4 - Y.*Z4)*S^2.*Y.^2*(S_v)^2)/(4*Z4^2) \\
& + (9*S^2*(S_v)^2)/(2*exp(5*Z4)*Z4) - (S^2*(S_v)^2)/(exp(4*Z4)*Z4) \\
& + \frac{(25*S^2*(S_v)^2)/(4*exp(3*Z4)*Z4)}{(25*S^2*(S_v)^2)/(4*exp(3*Z4)*Z4) - (3*S^2*(S_v)^2)/(exp(2*Z4)*Z4)} \\
& (3*S^2*(S_v)^2)/(4*exp(Z4)*Z4) + (3*exp(-3*Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/(4*Z4) \\
& + (3*exp(-Z4 - 2.*Y.*Z4)*S^2*(S_v)^2)/(4*Z4) + (3*exp(-4*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4 - (2*exp(-3*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4 + (2*exp(-2*Z4 - Y.*Z4)*S^2*(S_v)^2)/Z4 \\
& - \frac{(9*S^2.*Y.(S_v)^2)/(4*exp(5*Z4)*Z4)}{(9*S^2.*Y.(S_v)^2)/(4*exp(5*Z4)*Z4) + (3*S^2.*Y.(S_v)^2)/(exp(4*Z4)*Z4)} \\
& (11*S^2.*Y.(S_v)^2)/(exp(3*Z4)*Z4) + (7*S^2.*Y.(S_v)^2)/(exp(2*Z4)*Z4) \\
& - (7*S^2.*Y.(S_v)^2)/(4*exp(Z4)*Z4) - (exp(-Z4 - 2.*Y.*Z4)*S^2.*Y.(S_v)^2)/Z4 - (2*exp(-2*Z4 - Y.*Z4)*S^2.*Y.(S_v)^2)/Z4 + (15*S^2.*Y.^2*(S_v)^2)/(2*exp(5*Z4)*Z4) \\
& - \frac{(13*S^2.*Y.^2*(S_v)^2)/(exp(4*Z4)*Z4)}{(13*S^2.*Y.^2*(S_v)^2)/(exp(4*Z4)*Z4) + (41*S^2.*Y.^2*(S_v)^2)/(4*exp(3*Z4)*Z4)} \\
& (6*S^2.*Y.^2*(S_v)^2)/(exp(2*Z4)*Z4) + (5*S^2.*Y.^2*(S_v)^2)/(4*exp(Z4)*Z4) \\
& + \frac{(3*exp(-3*Z4 - 2.*Y.*Z4)*S^2.*Y.^2*(S_v)^2)/(4*Z4)}{(3*exp(-3*Z4 - 2.*Y.*Z4)*S^2.*Y.^2*(S_v)^2)/(4*Z4) - (exp(-2*Z4 - 2.*Y.*Z4)*S^2.*Y.^2*(S_v)^2)/Z4} \\
& - \frac{(9*S^2.*Y.^3*(S_v)^2)/(4*exp(5*Z4)*Z4)}{(9*S^2.*Y.^3*(S_v)^2)/(4*exp(5*Z4)*Z4) + (6*S^2.*Y.^3*(S_v)^2)/(exp(4*Z4)*Z4)} \\
& (11*S^2.*Y.^3*(S_v)^2)/(2*exp(3*Z4)*Z4) + (2*S^2.*Y.^3*(S_v)^2)/(exp(2*Z4)*Z4) \\
& - \frac{(S^2.*Y.^3*(S_v)^2)/(4*exp(Z4)*Z4)}{(S^2.*Y.^3*(S_v)^2)/(4*exp(Z4)*Z4) - (3*S^2*Z4*(S_v)^2)/(4*exp(5*Z4))} \\
& (3*S^2*Z4*(S_v)^2)/(4*exp(3*Z4)) + \frac{(S^2.*Y.*Z4*(S_v)^2)/(exp(3*Z4))}{(S^2.*Y.*Z4*(S_v)^2)/(exp(3*Z4))} \\
& (S^2.*Y.^2*Z4*(S_v)^2)/(exp(4*Z4)) \\
& + \frac{(S^2.*Y.^2*Z4*(S_v)^2)/(2*exp(3*Z4))}{(S^2.*Y.^2*Z4*(S_v)^2)/(2*exp(3*Z4)) - (S^2.*Y.^3*Z4*(S_v)^2)/(exp(3*Z4))} \\
& (3*S^2.*Y.^4*Z4*(S_v)^2)/(4*exp(5*Z4)) - (S^2.*Y.^4*Z4*(S_v)^2)/(exp(4*Z4)) \\
& + \frac{(S^2.*Y.^4*Z4*(S_v)^2)/(4*exp(3*Z4))}{(S^2.*Y.^4*Z4*(S_v)^2)/(4*exp(3*Z4)) + (S^2*Z4^2*(S_v)^2)/(4*exp(4*Z4))} \\
& (S^2.*Y.^2*Z4^2*(S_v)^2)/(2*exp(4*Z4)) + (S^2.*Y.^4*Z4^2*(S_v)^2)/(4*exp(4*Z4));
\end{aligned}$$

Ns4=Nf4+Nc+Ny4;  
Phi4=Nf4./[Nc+Ny4];  
Be4=1./[1+Phi4];  
Gf4=Nf4./Ns4;  
Gh4=[Nc+Ny4]./Ns4;  
Nh4=Nc+Ny4;

$$\begin{aligned}
Z5 &= 15; \\
Nf5 &= Br*[(Z5^2).*exp(-2.*Y.*Z5)+(Z5^2)*exp(-2*Z5)-2*Z5^2.*exp(-Z5-Y.*Z5)]; \\
Ny5 &= 1 - exp(-2*Z5) + exp(-Z5 - Y.*Z5) - (2*S)/exp(2*Z5) + 2*exp(-Z5 - Y.*Z5)*S - S^2/exp(2*Z5) + exp(-Z5 - Y.*Z5)*S^2 - 2.*Y + Y.^2 + Y.^2/exp(2*Z5) - exp(-Z5 - Y.*Z5).*Y.^2 ... \\
& + (2*S.*Y.^2)/exp(2*Z5) - 2*exp(-Z5 - Y.*Z5)*S.*Y.^2 + (S^2.*Y.^2)/exp(2*Z5) - exp(-Z5 - Y.*Z5)*S^2.*Y.^2 + 1/(exp(2*Z5)*Z5^2) + 1./(exp(2.*Y.*Z5)*Z5^2) ... \\
& - (2*exp(-Z5 - Y.*Z5))/Z5^2 + (2*S)/(exp(2*Z5)*Z5^2) + (2*S)./(exp(2.*Y.*Z5)*Z5^2) - (4*exp(-Z5 - Y.*Z5)*S)/Z5^2 + S^2/(exp(2*Z5)*Z5^2) + S^2./(exp(2.*Y.*Z5)*Z5^2) ...
\end{aligned}$$

$$\begin{aligned}
& - (2*\exp(-Z5 - Y.*Z5)*S^2)/Z5^2 + 2/(\exp(Z5)*Z5) - 2./(\exp(Y.*Z5)*Z5) + (2*S)/(\exp(Z5)*Z5) - \\
& (2*S)./(\exp(Y.*Z5)*Z5) - (2.*Y)/(\exp(Z5)*Z5) + (2.*Y)/(\exp(Y.*Z5)*Z5) \dots \\
& - (2*S.*Y)/(\exp(Z5)*Z5) + (2*S.*Y)/(\exp(Y.*Z5)*Z5) - Z5/\exp(Z5) - (S*Z5)/\exp(Z5) + \\
& (Y.*Z5)/\exp(Z5) + (S.*Y.*Z5)/\exp(Z5) + (Y.^2*Z5)/\exp(Z5) + (S.*Y.^2*Z5)/\exp(Z5) - (Y.^3*Z5)/\exp(Z5) \\
& \dots \\
& - (S.*Y.^3*Z5)/\exp(Z5) + Z5^2/(4*\exp(2*Z5)) + (S*Z5^2)/(2*\exp(2*Z5)) + (S^2*Z5^2)/(4*\exp(2*Z5)) \\
& - (Y.^2*Z5^2)/(2*\exp(2*Z5)) - (S.*Y.^2*Z5^2)/\exp(2*Z5) \dots \\
& - (S^2.*Y.^2*Z5^2)/(2*\exp(2*Z5)) + (Y.^4*Z5^2)/(4*\exp(2*Z5)) + (S.*Y.^4*Z5^2)/(2*\exp(2*Z5)) + \\
& (S^2.*Y.^4*Z5^2)/(4*\exp(2*Z5)) - (7*S*(S_v))/(2*\exp(3*Z5)) \dots \\
& + (2*S*(S_v))/\exp(2*Z5) + (S*(S_v))/\exp(Z5) - (\exp(-Z5 - 2.*Y.*Z5)*S*(S_v))/2 - \\
& (5*S^2*(S_v))/\exp(3*Z5) + (2*S^2*(S_v))/\exp(2*Z5) - (S^2*(S_v))/(2*\exp(Z5)) \dots \\
& - (\exp(-Z5 - 2.*Y.*Z5)*S^2*(S_v))/2 - (2*S.*Y.(S_v))/\exp(2*Z5) - (3*S.*Y.(S_v))/\exp(Z5) + \\
& (3*S^2.*Y.(S_v))/(2*\exp(3*Z5)) - (2*S^2.*Y.(S_v))/\exp(2*Z5) \dots \\
& + (S^2.*Y.(S_v))/(2*\exp(Z5)) + (13*S.*Y.^2*(S_v))/(2*\exp(3*Z5)) - (4*S.*Y.^2*(S_v))/\exp(2*Z5) + \\
& (3*S.*Y.^2*(S_v))/\exp(Z5) + (\exp(-Z5 - 2.*Y.*Z5)*S.*Y.^2*(S_v))/2 \dots \\
& + (5*S^2.*Y.^2*(S_v))/\exp(3*Z5) - (2*S^2.*Y.^2*(S_v))/\exp(2*Z5) + (S^2.*Y.^2*(S_v))/(2*\exp(Z5)) \\
& + (\exp(-Z5 - 2.*Y.*Z5)*S^2.*Y.^2*(S_v))/2 - (3*S.*Y.^3*(S_v))/\exp(3*Z5) \dots \\
& + (4*S.*Y.^3*(S_v))/\exp(2*Z5) - (S.*Y.^3*(S_v))/\exp(Z5) - (3*S^2.*Y.^3*(S_v))/(2*\exp(3*Z5)) + \\
& (2*S^2.*Y.^3*(S_v))/\exp(2*Z5) - (S^2.*Y.^3*(S_v))/(2*\exp(Z5)) \dots \\
& + (3*S*(S_v))/\exp(4*Z5)*Z5^3) - (4*S*(S_v))/\exp(3*Z5)*Z5^3) + (S*(S_v))/\exp(2*Z5)*Z5^3) + \\
& (S*(S_v))./(\exp(2.*Y.*Z5)*Z5^3) + (3*\exp(-2*Z5 - 2.*Y.*Z5)*S*(S_v))/Z5^3 \dots \\
& - (4*\exp(-Z5 - 2.*Y.*Z5)*S*(S_v))/Z5^3 - (6*\exp(-3*Z5 - Y.*Z5)*S*(S_v))/Z5^3 + (8*\exp(-2*Z5 - \\
& Y.*Z5)*S*(S_v))/Z5^3 - (2*\exp(-Z5 - Y.*Z5)*S*(S_v))/Z5^3 \dots \\
& + (3*S^2*(S_v))/\exp(4*Z5)*Z5^3) - (4*S^2*(S_v))/\exp(3*Z5)*Z5^3) + (S^2*(S_v))/\exp(2*Z5)*Z5^3) + \\
& (S^2*(S_v))./(\exp(2.*Y.*Z5)*Z5^3) + (S^2*(S_v))./(\exp(2.*Y.*Z5)*Z5^3) + (3*\exp(-2*Z5 - \\
& 2.*Y.*Z5)*S^2*(S_v))/Z5^3 \dots \\
& - (4*\exp(-Z5 - 2.*Y.*Z5)*S^2*(S_v))/Z5^3 - (6*\exp(-3*Z5 - Y.*Z5)*S^2*(S_v))/Z5^3 + (8*\exp(-2*Z5 - \\
& Y.*Z5)*S^2*(S_v))/Z5^3 - (2*\exp(-Z5 - Y.*Z5)*S^2*(S_v))/Z5^3 \dots \\
& + (11*S*(S_v))/\exp(3*Z5)*Z5^2) - (8*S*(S_v))/\exp(2*Z5)*Z5^2) + (2*S*(S_v))/\exp(Z5)*Z5^2) - \\
& (S*(S_v))./(\exp(3.*Y.*Z5)*Z5^2) - (2*S*(S_v))./(\exp(Y.*Z5)*Z5^2) \dots \\
& - (\exp(-Z5 - 2.*Y.*Z5)*S*(S_v))/Z5^2 - (9*\exp(-2*Z5 - Y.*Z5)*S*(S_v))/Z5^2 + (8*\exp(-Z5 - \\
& Y.*Z5)*S*(S_v))/Z5^2 + (8*S^2*(S_v))/\exp(3*Z5)*Z5^2); \dots \\
& - (4*S^2*(S_v))/\exp(2*Z5)*Z5^2) + (S^2*(S_v))/\exp(Z5)*Z5^2) - (exp(-Z5 - \\
& S^2*(S_v))./(\exp(3.*Y.*Z5)*Z5^2) - (S^2*(S_v))./(\exp(Y.*Z5)*Z5^2) - (exp(-Z5 - \\
& 2.*Y.*Z5)*S^2*(S_v))/Z5^2 \dots \\
& - (6*\exp(-2*Z5 - Y.*Z5)*S^2*(S_v))/Z5^2 + (4*\exp(-Z5 - Y.*Z5)*S^2*(S_v))/Z5^2 - \\
& (6*S.*Y.(S_v))/\exp(3*Z5)*Z5^2) + (8*S.*Y.(S_v))/\exp(2*Z5)*Z5^2) \dots \\
& - (2*S.*Y.(S_v))/\exp(Z5)*Z5^2) + (2*S.*Y.(S_v))/\exp(Y.*Z5)*Z5^2) + (6*\exp(-2*Z5 - \\
& Y.*Z5)*S.*Y.(S_v))/Z5^2 - (8*\exp(-Z5 - Y.*Z5)*S.*Y.(S_v))/Z5^2 \dots \\
& - (3*S^2.*Y.(S_v))/\exp(3*Z5)*Z5^2) + (4*S^2.*Y.(S_v))/\exp(2*Z5)*Z5^2) \dots \\
& (S^2.*Y.(S_v))/\exp(Z5)*Z5^2) + (S^2.*Y.(S_v))/\exp(Y.*Z5)*Z5^2) \dots \\
& + (3*\exp(-2*Z5 - Y.*Z5)*S^2.*Y.(S_v))/Z5^2 - (4*\exp(-Z5 - Y.*Z5)*S^2.*Y.(S_v))/Z5^2 + \\
& (S*(S_v))/Z5 + (2*S*(S_v))/\exp(3*Z5)*Z5) + (9*S*(S_v))/\exp(2*Z5)*Z5) \dots \\
& - (4*S*(S_v))/\exp(Z5)*Z5) + (S*(S_v))./(\exp(2.*Y.*Z5)*Z5) - (2*\exp(-2*Z5 - Y.*Z5)*S*(S_v))/Z5 + \\
& (\exp(-Z5 - Y.*Z5)*S*(S_v))/Z5 + (2*S^2*(S_v))/\exp(3*Z5)*Z5) \dots \\
& + (S^2*(S_v))/\exp(2*Z5)*Z5) - (2*\exp(-2*Z5 - Y.*Z5)*S^2*(S_v))/Z5 - (exp(-Z5 - \\
& Y.*Z5)*S^2*(S_v))/Z5 - (2*S.*Y.(S_v))/Z5 - (13*S.*Y.(S_v))/\exp(2*Z5)*Z5) \dots \\
& + (8*S.*Y.(S_v))/\exp(Z5)*Z5) - (S.*Y.(S_v))./(\exp(2.*Y.*Z5)*Z5) - \\
& (2*S^2.*Y.(S_v))/\exp(2*Z5)*Z5) + (2*\exp(-Z5 - Y.*Z5)*S^2.*Y.(S_v))/Z5 + (S.*Y.^2*(S_v))/Z5 \dots \\
& + (3*S.*Y.^2*(S_v))/\exp(4*Z5)*Z5) - (4*S.*Y.^2*(S_v))/\exp(3*Z5)*Z5) + \\
& (4*S.*Y.^2*(S_v))/\exp(2*Z5)*Z5) - (4*S.*Y.^2*(S_v))/\exp(Z5)*Z5) \dots \\
& - (3*\exp(-3*Z5 - Y.*Z5)*S.*Y.^2*(S_v))/Z5 + (4*\exp(-2*Z5 - Y.*Z5)*S.*Y.^2*(S_v))/Z5 - (\exp(-Z5 - \\
& Y.*Z5)*S.*Y.^2*(S_v))/Z5 + (3*S^2.*Y.^2*(S_v))/\exp(4*Z5)*Z5) \dots \\
& - (4*S^2.*Y.^2*(S_v))/\exp(3*Z5)*Z5) + (S^2.*Y.^2*(S_v))/\exp(2*Z5)*Z5) - (3*\exp(-3*Z5 - \\
& Y.*Z5)*S^2.*Y.^2*(S_v))/Z5 + (4*\exp(-2*Z5 - Y.*Z5)*S^2.*Y.^2*(S_v))/Z5 \dots
\end{aligned}$$

$$\begin{aligned}
& - \frac{(\exp(-Z5) - Y.*Z5)*S^2.*Y.^2*(S_v)/Z5}{(7*S^2*Z5*(S_v)/(4*exp(2*Z5)) - (3*S^2*Z5*(S_v)/(4*exp(4*Z5)) - (3*S^2*Z5*(S_v)/(4*exp(2*Z5)) ... \\
& + (2*S.*Y.*Z5*(S_v))/exp(2*Z5) + (S^2.*Y.*Z5*(S_v))/exp(2*Z5) + (S.*Y.^2*Z5*(S_v))/exp(3*Z5) + \\
& (3*S.*Y.^2*Z5*(S_v))/(2*exp(2*Z5)) + (S^2.*Y.^2*Z5*(S_v))/exp(3*Z5) ... \\
& + (S^2.*Y.^2*Z5*(S_v))/(2*exp(2*Z5)) - (2*S.*Y.^3*Z5*(S_v))/exp(2*Z5) - \\
& (S^2.*Y.^3*Z5*(S_v))/exp(2*Z5) + (3*S.*Y.^4*Z5*(S_v))/(4*exp(4*Z5)) - \\
& (S.*Y.^4*Z5*(S_v))/exp(3*Z5) ... \\
& + (S.*Y.^4*Z5*(S_v))/(4*exp(2*Z5)) + (3*S^2.*Y.^4*Z5*(S_v))/(4*exp(4*Z5)) - \\
& (S^2.*Y.^4*Z5*(S_v))/exp(3*Z5) + (S^2.*Y.^4*Z5*(S_v))/(4*exp(2*Z5)) + \\
& (S^2*Z5^2*(S_v))/(2*exp(3*Z5)) ... \\
& + (S^2*Z5^2*(S_v))/(2*exp(3*Z5)) - (S.*Y.^2*Z5^2*(S_v))/exp(3*Z5) - \\
& (S^2.*Y.^2*Z5^2*(S_v))/exp(3*Z5) + (S.*Y.^4*Z5^2*(S_v))/(2*exp(3*Z5)) ... \\
& + (S^2.*Y.^4*Z5^2*(S_v))/(2*exp(3*Z5)) + (9*S^2*(S_v)^2)/(16*exp(6*Z5)) - \\
& (23*S^2*(S_v)^2)/(8*exp(4*Z5)) + (2*S^2*(S_v)^2)/exp(3*Z5) + (S^2*(S_v)^2)/(16*exp(2*Z5)) ... \\
& - (\exp(-2*Z5) - 2.*Y.*Z5)*S^2*(S_v)^2/2 - \exp(-3*Z5) - Y.*Z5)*S^2*(S_v)^2 - \\
& (2*S^2.*Y.(S_v)^2)/exp(3*Z5) - (S^2.*Y.(S_v)^2)/exp(2*Z5) + (9*S^2.*Y.^2*(S_v)^2)/(8*exp(6*Z5)) \\
& ... \\
& - (3*S^2.*Y.^2*(S_v)^2)/(2*exp(5*Z5)) + (11*S^2.*Y.^2*(S_v)^2)/(2*exp(4*Z5)) - \\
& (7*S^2.*Y.^2*(S_v)^2)/(2*exp(3*Z5)) + (15*S^2.*Y.^2*(S_v)^2)/(8*exp(2*Z5)) ... \\
& + (\exp(-2*Z5) - 2.*Y.*Z5)*S^2.*Y.^2*(S_v)^2/2 + \exp(-3*Z5) - Y.*Z5)*S^2.*Y.^2*(S_v)^2 - \\
& (3*S^2.*Y.^3*(S_v)^2)/exp(4*Z5) + (4*S^2.*Y.^3*(S_v)^2)/exp(3*Z5) ... \\
& - (S^2.*Y.^3*(S_v)^2)/exp(2*Z5) + (9*S^2.*Y.^4*(S_v)^2)/(16*exp(6*Z5)) - \\
& (3*S^2.*Y.^4*(S_v)^2)/(2*exp(5*Z5)) + (11*S^2.*Y.^4*(S_v)^2)/(8*exp(4*Z5)) ... \\
& - (S^2.*Y.^4*(S_v)^2)/(2*exp(3*Z5)) + (S^2.*Y.^4*(S_v)^2)/(16*exp(2*Z5)) + \\
& (9*S^2*(S_v)^2)/(4*exp(6*Z5)*Z5^4) - (6*S^2*(S_v)^2)/(exp(5*Z5)*Z5^4) ... \\
& + (11*S^2*(S_v)^2)/(2*exp(4*Z5)*Z5^4) - (2*S^2*(S_v)^2)/(exp(3*Z5)*Z5^4) + \\
& (S^2*(S_v)^2)/(4*exp(2*Z5)*Z5^4) + (S^2*(S_v)^2)/(4*exp(2.*Y.*Z5)*Z5^4) ... \\
& + (9*exp(-4*Z5) - 2.*Y.*Z5)*S^2*(S_v)^2/(4*Z5^4) - (6*exp(-3*Z5) - 2.*Y.*Z5)*S^2*(S_v)^2/Z5^4 + \\
& (11*exp(-2*Z5) - 2.*Y.*Z5)*S^2*(S_v)^2/(2*Z5^4) ... \\
& - (2*exp(-Z5) - 2.*Y.*Z5)*S^2*(S_v)^2/Z5^4 - (9*exp(-5*Z5) - Y.*Z5)*S^2*(S_v)^2/(2*Z5^4) + \\
& (12*exp(-4*Z5) - Y.*Z5)*S^2*(S_v)^2/Z5^4 - (11*exp(-3*Z5) - Y.*Z5)*S^2*(S_v)^2/Z5^4 ... \\
& + (4*exp(-2*Z5) - Y.*Z5)*S^2*(S_v)^2/Z5^4 - (\exp(-Z5) - Y.*Z5)*S^2*(S_v)^2/(2*Z5^4) + \\
& (12*S^2*(S_v)^2)/(exp(5*Z5)*Z5^3) - (22*S^2*(S_v)^2)/(exp(4*Z5)*Z5^3) ... \\
& + (27*S^2*(S_v)^2)/(2*exp(3*Z5)*Z5^3) - (4*S^2*(S_v)^2)/(exp(2*Z5)*Z5^3) + \\
& (S^2*(S_v)^2)/(2*exp(Z5)*Z5^3) - (S^2*(S_v)^2)/(2*exp(3.*Y.*Z5)*Z5^3) ... \\
& - (S^2*(S_v)^2)/(2*exp(Y.*Z5)*Z5^3) - (3*exp(-2*Z5) - 3.*Y.*Z5)*S^2*(S_v)^2/(2*Z5^3) + (2*exp(- \\
& Z5 - 3.*Y.*Z5)*S^2*(S_v)^2/Z5^3 - (3*exp(-3*Z5) - 2.*Y.*Z5)*S^2*(S_v)^2/(2*Z5^3) ... \\
& + (2*exp(-2*Z5) - 2.*Y.*Z5)*S^2*(S_v)^2/Z5^3 - (\exp(-Z5) - 2.*Y.*Z5)*S^2*(S_v)^2/(2*Z5^3) - \\
& (9*exp(-4*Z5) - Y.*Z5)*S^2*(S_v)^2/Z5^3 + (18*exp(-3*Z5) - Y.*Z5)*S^2*(S_v)^2/Z5^3 ... \\
& - (25*exp(-2*Z5) - Y.*Z5)*S^2*(S_v)^2/(2*Z5^3) + (4*exp(-Z5) - Y.*Z5)*S^2*(S_v)^2/Z5^3 - \\
& (9*S^2.*Y.(S_v)^2)/(2*exp(5*Z5)*Z5^3) + (12*S^2.*Y.(S_v)^2)/(exp(4*Z5)*Z5^3) ... \\
& - (11*S^2.*Y.(S_v)^2)/(exp(3*Z5)*Z5^3) + (4*S^2.*Y.(S_v)^2)/(exp(2*Z5)*Z5^3) - \\
& (S^2.*Y.(S_v)^2)/(2*exp(Z5)*Z5^3) + (S^2.*Y.(S_v)^2)/(2*exp(Y.*Z5)*Z5^3) ... \\
& + (9*exp(-4*Z5) - Y.*Z5)*S^2.*Y.(S_v)^2/(2*Z5^3) - (12*exp(-3*Z5) - Y.*Z5)*S^2.*Y.(S_v)^2/Z5^3 ... \\
& - (4*exp(-Z5) - Y.*Z5)*S^2.*Y.(S_v)^2/Z5^3 + (S^2*(S_v)^2)/(4*Z5^2) + \\
& (9*S^2*(S_v)^2)/(4*exp(6*Z5)*Z5^2) - (3*S^2*(S_v)^2)/(exp(5*Z5)*Z5^2) + \\
& (19*S^2*(S_v)^2)/(exp(4*Z5)*Z5^2) ... \\
& - (19*S^2*(S_v)^2)/(exp(3*Z5)*Z5^2) + (35*S^2*(S_v)^2)/(4*exp(2*Z5)*Z5^2) - \\
& (2*S^2*(S_v)^2)/(exp(Z5)*Z5^2) + (S^2*(S_v)^2)/(4*exp(4.*Y.*Z5)*Z5^2) ... \\
& + (S^2*(S_v)^2)/(2*exp(2.*Y.*Z5)*Z5^2) + (\exp(-Z5) - 3.*Y.*Z5)*S^2*(S_v)^2/Z5^2 + (5*exp(-2*Z5) - \\
& 2.*Y.*Z5)*S^2*(S_v)^2/Z5^2 - (2*exp(-Z5) - 2.*Y.*Z5)*S^2*(S_v)^2/Z5^2 ... \\
& - (9*exp(-5*Z5) - Y.*Z5)*S^2*(S_v)^2/(4*Z5^2) + (3*exp(-4*Z5) - Y.*Z5)*S^2*(S_v)^2/Z5^2 + \\
& (5*exp(-3*Z5) - Y.*Z5)*S^2*(S_v)^2/Z5^2 - (\exp(-2*Z5) - Y.*Z5)*S^2*(S_v)^2/Z5^2 ... \\
& + (\exp(-Z5) - Y.*Z5)*S^2*(S_v)^2/(4*Z5^2) - (S^2.*Y.(S_v)^2)/(2*Z5^2) - \\
& (15*S^2.*Y.(S_v)^2)/(exp(4*Z5)*Z5^2) + (26*S^2.*Y.(S_v)^2)/(exp(3*Z5)*Z5^2) ...
\end{aligned}$$

$$\begin{aligned}
& - \frac{(29*S^2.*Y.*(S_v)^2)/(2*\exp(2*Z5)*Z5^2)}{(S^2.*Y.*(S_v)^2)./(2*\exp(2.*Y.*Z5)*Z5^2)} + \frac{(4*S^2.*Y.*(S_v)^2)/(\exp(Z5)*Z5^2)}{(2*exp(-2*Z5 - 2.*Y.*Z5)*S^2.*Y.*(S_v)^2)/(2*Z5^2)} \\
& + \frac{(2*exp(-Z5 - 2.*Y.*Z5)*S^2.*Y.*(S_v)^2)/Z5^2}{(9*S^2.*Y.^2*(S_v)^2)/(4*\exp(6*Z5)*Z5^2)} + \frac{(S^2.*Y.^2*(S_v)^2)/(4*Z5^2)}{(6*S^2.*Y.^2*(S_v)^2)/(\exp(5*Z5)*Z5^2)} \\
& + \frac{(31*S^2.*Y.^2*(S_v)^2)/(4*\exp(4*Z5)*Z5^2)}{(23*S^2.*Y.^2*(S_v)^2)/(4*\exp(2*Z5)*Z5^2)} - \frac{(8*S^2.*Y.^2*(S_v)^2)/(\exp(3*Z5)*Z5^2)}{(2*S^2.*Y.^2*(S_v)^2)/(4*\exp(Z5)*Z5^2)} \\
& - \frac{(9*exp(-5*Z5 - Y.*Z5)*S^2.*Y.^2*(S_v)^2)/(4*Z5^2)}{(Y.*Z5)*S^2.*Y.^2*(S_v)^2/Z5^2} + \frac{(6*exp(-4*Z5 - Y.*Z5)*S^2.*Y.^2*(S_v)^2)/(2*Z5^2)}{(11*exp(-3*Z5 - Y.*Z5)*S^2.*Y.^2*(S_v)^2)/(2*Z5^2)} \\
& + \frac{(2*exp(-2*Z5 - Y.*Z5)*S^2.*Y.^2*(S_v)^2)/Z5^2}{(9*S^2*(S_v)^2)/(2*\exp(5*Z5)*Z5)} - \frac{(S^2*(S_v)^2)/(\exp(4*Z5)*Z5)}{(25*S^2*(S_v)^2)/(4*\exp(3*Z5)*Z5)} \\
& + \frac{(3*S^2*(S_v)^2)/(\exp(2*Z5)*Z5)}{(3*S^2*(S_v)^2)/(4*\exp(Z5)*Z5)} + \frac{(3*exp(-3*Z5 - 2.*Y.*Z5)*S^2*(S_v)^2)/(4*Z5)}{(3*exp(-Z5 - 2.*Y.*Z5)*S^2*(S_v)^2)/(4*Z5)} \\
& + \frac{(3*exp(-4*Z5 - Y.*Z5)*S^2*(S_v)^2)/Z5}{(2*exp(-3*Z5 - Y.*Z5)*S^2*(S_v)^2)/Z5} - \frac{(2*exp(-2*Z5 - Y.*Z5)*S^2*(S_v)^2)/Z5}{(9*S^2.*Y.*(S_v)^2)/(4*\exp(5*Z5)*Z5)} \\
& + \frac{(3*S^2.*Y.*(S_v)^2)/(exp(4*Z5)*Z5)}{(11*S^2.*Y.*(S_v)^2)/(exp(3*Z5)*Z5)} + \frac{(7*S^2.*Y.*(S_v)^2)/(exp(2*Z5)*Z5)}{(7*S^2.*Y.*(S_v)^2)/(4*\exp(5*Z5)*Z5)} \\
& - \frac{(exp(-Z5 - 2.*Y.*Z5)*S^2.*Y.*(S_v)^2)/Z5}{(Y.*Z5)*S^2.*Y.*(S_v)^2/Z5} + \frac{(2*exp(5*Z5)*Z5)}{(15*S^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z5)*Z5)} \\
& - \frac{(13*S^2.*Y.^2*(S_v)^2)/(exp(4*Z5)*Z5)}{(6*S^2.*Y.^2*(S_v)^2)/(exp(2*Z5)*Z5)} + \frac{(41*S^2.*Y.^2*(S_v)^2)/(4*\exp(3*Z5)*Z5)}{(5*S^2.*Y.^2*(S_v)^2)/(4*\exp(Z5)*Z5)} \\
& + \frac{(3*exp(-3*Z5 - 2.*Y.*Z5)*S^2.*Y.^2*(S_v)^2)/(4*Z5)}{(2.*Y.*Z5)*S^2.*Y.^2*(S_v)^2/Z5} + \frac{(exp(-Z5 - 2.*Y.*Z5)*S^2.*Y.^2*(S_v)^2)/(4*Z5)}{(9*S^2.*Y.^3*(S_v)^2)/(4*\exp(5*Z5)*Z5)} \\
& - \frac{(11*S^2.*Y.^3*(S_v)^2)/(2*\exp(3*Z5)*Z5)}{(S^2.*Y.^3*(S_v)^2)/(4*\exp(Z5)*Z5)} - \frac{(3*S^2*Z5*(S_v)^2)/(4*exp(3*Z5))}{(S^2.*Y.^2*Z5*(S_v)^2)/(4*exp(5*Z5))} \\
& (S^2.*Y.^2*Z5*(S_v)^2)/exp(4*Z5) ... \\
& + \frac{(S^2.*Y.^2*Z5*(S_v)^2)/(2*\exp(3*Z5))}{(3*S^2.*Y.^4*Z5*(S_v)^2)/(4*\exp(5*Z5))} - \frac{(S^2.*Y.^4*Z5*(S_v)^2)/exp(4*Z5)}{(S^2.*Y.^4*Z5*(S_v)^2)/(4*\exp(3*Z5))} \\
& + \frac{(S^2.*Y.^4*Z5*(S_v)^2)/(4*\exp(3*Z5))}{(S^2.*Y.^2*Z5^2*(S_v)^2)/(4*exp(4*Z5))} - \frac{(S^2.*Y.^2*Z5^2*(S_v)^2)/(4*exp(4*Z5))}{(S^2.*Y.^2*Z5^2*(S_v)^2)/(2*\exp(4*Z5))} + \frac{(S^2.*Y.^4*Z5^2*(S_v)^2)/(4*exp(4*Z5))}{(S^2.*Y.^2*Z5^2*(S_v)^2)/(2*\exp(4*Z5))};
\end{aligned}$$

Ns5=Nf5+Nc+Ny5;  
 Phi5=Nf5./[Nc+Ny5];  
 Be5=1./[1+Phi5];  
 Gf5=Nf5./Ns5;  
 Gh5=[Nc+Ny5]./Ns5;  
 Nh5=Nc+Ny5;

```

plot(Y,Ns1,'b',Y,Ns2,'g',Y,Ns3,'r',Y,Ns4,'k',Y,Ns5,'m')

% plot(Y,Be1,'b',Y,Be2,'g',Y,Be3,'r',Y,Be4,'k',Y,Be5,'m')

% plot(Y,Phi1,'b',Y,Phi2,'g',Y,Phi3,'r',Y,Phi4,'k',Y,Phi5,'m')

% plot(Y,Gf1,'b',Y,Gf2,'g',Y,Gf3,'r',Y,Gf4,'k',Y,Gf5,'m')

% plot(Y,Gh1,'b',Y,Gh2,'g',Y,Gh3,'r',Y,Gh4,'k',Y,Gh5,'m')

% plot(Y,Nf1,'b',Y,Nf2,'g',Y,Nf3,'r',Y,Nf4,'k',Y,Nf5,'m')

% plot(Y,Nh1,'b',Y,Nh2,'g',Y,Nh3,'r',Y,Nh4,'k',Y,Nh5,'m')

% plot(Nh1,Nf1,'b',Nh2,Nf2,'g',Nh3,Nf3,'r',Nh4,Nf4,'k',Nh5,Nf5,'m')
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```

### 1.3. Distribution of $N_s$ , $Be$ , $\Phi$ , $G_F$ , $G_H$ , $N_C$ and $N_H$ versus $Y$ for a range of

$Pe$  and set of  $S$ ,  $S_v$ ,  $Z$  &  $Br$

```

S=1; S_v=1; Z=1; Br=1;
% S=5; S_v=0.75; Z=7.5; Br=0.4;

% % % % S=2; S_v=5; Z=6; Br=0.5;
% % % % S=2; S_v=1.5; Z=5; Br=0.4;
% % % % S=25; S_v=15; Z=10; Br=0.6;
% % % % S=10; S_v=25; Z=20; Br=0.5;

q=1.86;
s=1;
Dh=250*10^-6;
Y=0:0.005:1;

Nf=Br*[(Z^2).*exp(-2.*Y.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-Y.*Z)];

```

$$Ny=1 - \exp(-2*Z) + \exp(-Z - Y.*Z) - (2*S)/\exp(2*Z) + 2*\exp(-Z - Y.*Z)*S - S^2/\exp(2*Z) + \exp(-Z - Y.*Z)*S^2 - 2.*Y + Y.^2 + Y.^2/\exp(2*Z) - \exp(-Z - Y.*Z).*Y.^2 ...$$

$$+ (2*S.*Y.^2)/\exp(2*Z) - 2*\exp(-Z - Y.*Z)*S.*Y.^2 + (S^2.*Y.^2)/\exp(2*Z) - \exp(-Z - Y.*Z)*S^2.*Y.^2 + 1/(\exp(2*Z)*Z^2) + 1/(\exp(2.*Y.*Z)*Z^2) ...$$

$$- (2*\exp(-Z - Y.*Z))/Z^2 + (2*S)/(\exp(2*Z)*Z^2) + (2*S)./(\exp(2.*Y.*Z)*Z^2) - (4*\exp(-Z - Y.*Z)*S)/Z^2 + S^2/(\exp(2*Z)*Z^2) + S^2./(\exp(2.*Y.*Z)*Z^2) ...$$

$$- (2*\exp(-Z - Y.*Z)*S^2)/Z^2 + 2/(\exp(Z)*Z) - 2./(\exp(Y.*Z)*Z) + (2*S)/(\exp(Z)*Z) - (2*S)./(\exp(Y.*Z)*Z) - (2.*Y)/(\exp(Z)*Z) + (2.*Y)/(\exp(Y.*Z)*Z) ...$$

$$- (2*S.*Y)/(\exp(Z)*Z) + (2*S.*Y)/(\exp(Y.*Z)*Z) - Z/\exp(Z) - (S*Z)/\exp(Z) + (Y.*Z)/\exp(Z) + (S.*Y.*Z)/\exp(Z) + (Y.^2*Z)/\exp(Z) + (S.*Y.^2*Z)/\exp(Z) - (Y.^3*Z)/\exp(Z) ...$$

$$- (S.*Y.^3*Z)/\exp(Z) + Z^2/(4*\exp(2*Z)) + (S*Z^2)/(2*\exp(2*Z)) + (S^2*Z^2)/(4*\exp(2*Z)) - (Y.^2*Z^2)/(2*\exp(2*Z)) - (S.*Y.^2*Z^2)/\exp(2*Z) ...$$

$$- (S^2.*Y.^2*Z^2)/(2*\exp(2*Z)) + (Y.^4*Z^2)/(4*\exp(2*Z)) + (S.*Y.^4*Z^2)/(2*\exp(2*Z)) + (S^2.*Y.^4*Z^2)/(4*\exp(2*Z)) - (7*S*(S_v))/(2*\exp(3*Z)) ...$$

$$+ (2*S*(S_v))/\exp(2*Z) + (S*(S_v))/\exp(Z) - (\exp(-Z - 2.*Y.*Z)*S*(S_v))/2 - (5*S^2*(S_v))/\exp(3*Z) + (2*S^2*(S_v))/\exp(2*Z) - (S^2*(S_v))/(2*\exp(Z)) ...$$

$$- (\exp(-Z - 2.*Y.*Z)*S^2*(S_v))/2 - (2*S.*Y.*(S_v))/\exp(2*Z) - (3*S.*Y.*(S_v))/\exp(Z) + (3*S^2.*Y.*(S_v))/(2*\exp(3*Z)) - (2*S^2.*Y.*(S_v))/\exp(2*Z) ...$$

$$+ (S^2.*Y.*(S_v))/(2*\exp(Z)) + (13*S.*Y.^2*(S_v))/(2*\exp(3*Z)) - (4*S.*Y.^2*(S_v))/\exp(2*Z) + (3*S.*Y.^2*(S_v))/\exp(Z) + (\exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v))/2 - (3*S.*Y.^3*(S_v))/\exp(3*Z) ...$$

$$+ (4*S.*Y.^3*(S_v))/\exp(2*Z) - (S.*Y.^3*(S_v))/\exp(Z) - (3*S^2.*Y.^3*(S_v))/(2*\exp(3*Z)) + (2*S^2.*Y.^3*(S_v))/\exp(2*Z) - (S^2.*Y.^3*(S_v))/(2*\exp(Z)) ...$$

$$+ (3*S*(S_v))/(\exp(4*Z)*Z^3) - (4*S*(S_v))/(\exp(3*Z)*Z^3) + (S*(S_v))/(\exp(2*Z)*Z^3) + (S*(S_v))./(\exp(2.*Y.*Z)*Z^3) + (3*\exp(-2*Z - 2.*Y.*Z)*S*(S_v))/Z^3 ...$$

$$- (4*\exp(-Z - 2.*Y.*Z)*S*(S_v))/Z^3 - (6*\exp(-3*Z - Y.*Z)*S*(S_v))/Z^3 + (8*\exp(-2*Z - Y.*Z)*S*(S_v))/Z^3 - (2*\exp(-Z - Y.*Z)*S*(S_v))/Z^3 ...$$

$$+ (3*S^2*(S_v))/(\exp(4*Z)*Z^3) - (4*S^2*(S_v))/(\exp(3*Z)*Z^3) + (S^2*(S_v))/(\exp(2*Z)*Z^3) + (S^2*(S_v))./(\exp(2.*Y.*Z)*Z^3) + (3*\exp(-2*Z - 2.*Y.*Z)*S^2*(S_v))/Z^3 ...$$

$$\begin{aligned}
& - (4*\exp(-Z - 2.*Y.*Z)*S^2*(S_v))/Z^3 - (6*\exp(-3*Z - Y.*Z)*S^2*(S_v))/Z^3 + (8*\exp(-2*Z - Y.*Z)*S^2*(S_v))/Z^3 \\
& + (11*S^2*(S_v))/(exp(3*Z)*Z^2) - (8*S^2*(S_v))/(exp(2*Z)*Z^2) + (2*S^2*(S_v))/(exp(Z)*Z^2) - \\
& (S^2*(S_v))./(exp(3.*Y.*Z)*Z^2) - (2*S^2*(S_v))./(exp(Y.*Z)*Z^2) ... \\
& - (\exp(-Z - 2.*Y.*Z)*S^2*(S_v))/Z^2 - (9*\exp(-2*Z - Y.*Z)*S^2*(S_v))/Z^2 + (8*\exp(-Z - Y.*Z)*S^2*(S_v))/Z^2 + (8*S^2*(S_v))/(exp(3*Z)*Z^2) ... \\
& - (4*S^2*(S_v))/(exp(2*Z)*Z^2) + (S^2*(S_v))/(exp(Z)*Z^2) - (S^2*(S_v))./(exp(3.*Y.*Z)*Z^2) - \\
& (S^2*(S_v))./(exp(Y.*Z)*Z^2) - (\exp(-Z - 2.*Y.*Z)*S^2*(S_v))/Z^2 ... \\
& - (6*\exp(-2*Z - Y.*Z)*S^2*(S_v))/Z^2 + (4*\exp(-Z - Y.*Z)*S^2*(S_v))/Z^2 - \\
& (6*S.*Y.(S_v))/(exp(3*Z)*Z^2) + (8*S.*Y.(S_v))/(exp(2*Z)*Z^2) ... \\
& - (2*S.*Y.(S_v))/(exp(Z)*Z^2) + (2*S.*Y.(S_v))/(exp(Y.*Z)*Z^2) + (6*\exp(-2*Z - Y.*Z)*S^2*(S_v))/Z^2 - \\
& Y.*Z.*S.*Y.(S_v))/Z^2 - (8*\exp(-Z - Y.*Z)*S.*Y.(S_v))/Z^2 ... \\
& - (3*S^2.*Y.(S_v))/(exp(3*Z)*Z^2) + (4*S^2.*Y.(S_v))/(exp(2*Z)*Z^2) - \\
& (S^2.*Y.(S_v))/(exp(Z)*Z^2) + (S^2.*Y.(S_v))/(exp(Y.*Z)*Z^2) ... \\
& + (3*\exp(-2*Z - Y.*Z)*S^2.*Y.(S_v))/Z^2 - (4*\exp(-Z - Y.*Z)*S^2.*Y.(S_v))/Z^2 + (S^2*(S_v))/Z + \\
& (2*S^2*(S_v))/(exp(3*Z)*Z) + (9*S^2*(S_v))/(exp(2*Z)*Z) ... \\
& - (4*S^2*(S_v))/(exp(Z)*Z) + (S^2*(S_v))./(exp(2.*Y.*Z)*Z) - (2*\exp(-2*Z - Y.*Z)*S^2*(S_v))/Z + (\exp(-Z - Y.*Z)*S^2*(S_v))/Z + (2*S^2*(S_v))/(exp(3*Z)*Z) ... \\
& + (S^2*(S_v))/(exp(2*Z)*Z) - (2*\exp(-2*Z - Y.*Z)*S^2*(S_v))/Z - (\exp(-Z - Y.*Z)*S^2*(S_v))/Z - \\
& (2*S.*Y.(S_v))/Z - (13*S.*Y.(S_v))/(exp(2*Z)*Z) ... \\
& + (8*S.*Y.(S_v))/(exp(Z)*Z) - (S.*Y.(S_v))./(exp(2.*Y.*Z)*Z) - (2*S^2.*Y.(S_v))/(exp(2*Z)*Z) + \\
& (2*\exp(-Z - Y.*Z)*S^2.*Y.(S_v))/Z + (S.*Y.^2*(S_v))/Z ... \\
& + (3*S.*Y.^2*(S_v))/(exp(4*Z)*Z) - (4*S.*Y.^2*(S_v))/(exp(3*Z)*Z) + \\
& (4*S.*Y.^2*(S_v))/(exp(2*Z)*Z) - (4*S.*Y.^2*(S_v))/(exp(Z)*Z) ... \\
& - (3*\exp(-3*Z - Y.*Z)*S.*Y.^2*(S_v))/Z + (4*\exp(-2*Z - Y.*Z)*S.*Y.^2*(S_v))/Z - (\exp(-Z - Y.*Z)*S.*Y.^2*(S_v))/Z + (3*S^2.*Y.^2*(S_v))/(exp(4*Z)*Z) ... \\
& - (4*S^2.*Y.^2*(S_v))/(exp(3*Z)*Z) + (S^2.*Y.^2*(S_v))/(exp(2*Z)*Z) - (3*\exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v))/Z + (4*\exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v))/Z ... \\
& - (\exp(-Z - Y.*Z)*S^2.*Y.^2*(S_v))/Z - (3*S^2*(S_v))/(4*\exp(4*Z)) - (7*S^2*(S_v))/(4*\exp(2*Z)) - \\
& (3*S^2*(S_v))/(4*\exp(4*Z)) - (3*S^2*(S_v))/(4*\exp(2*Z)) ... \\
& + (2*S.*Y.^2*(S_v))/(exp(2*Z)) + (S^2.*Y.^2*(S_v))/(exp(2*Z)) + (S.*Y.^2*(S_v))/(exp(3*Z)) + \\
& (3*S.*Y.^2*(S_v))/(2*\exp(2*Z)) + (S^2.*Y.^2*(S_v))/(exp(3*Z)) ... \\
& + (S^2.*Y.^2*(S_v))/(2*\exp(2*Z)) - (2*S.*Y.^3*(S_v))/(exp(2*Z)) - \\
& (S^2.*Y.^3*(S_v))/(exp(2*Z)) + (3*S.*Y.^4*(S_v))/(4*\exp(4*Z)) - (S.*Y.^4*(S_v))/(exp(3*Z)) ... \\
& + (S.*Y.^4*(S_v))/(4*\exp(2*Z)) + (3*S^2.*Y.^4*(S_v))/(4*\exp(4*Z)) - \\
& (S^2.*Y.^4*(S_v))/(exp(3*Z)) + (S^2.*Y.^4*(S_v))/(4*\exp(2*Z)) + (S^2*(S_v))/(2*\exp(3*Z)) ... \\
& + (S^2*(S_v))/(2*\exp(3*Z)) - (S.*Y.^2*(S_v))/(exp(3*Z)) - (S^2.*Y.^2*(S_v))/(exp(3*Z)) + \\
& (S.*Y.^4*(S_v))/(2*\exp(3*Z)) ... \\
& + (S^2.*Y.^4*(S_v))/(2*\exp(3*Z)) + (9*S^2*(S_v)^2)/(16*\exp(6*Z)) - \\
& (23*S^2*(S_v)^2)/(8*\exp(4*Z)) + (2*S^2*(S_v)^2)/(exp(3*Z)) + (S^2*(S_v)^2)/(16*\exp(2*Z)) ... \\
& - (\exp(-2*Z - 2.*Y.*Z)*S^2*(S_v)^2)/2 - \exp(-3*Z - Y.*Z)*S^2*(S_v)^2 - \\
& (2*S^2.*Y.(S_v)^2)/(exp(3*Z)) - (S^2.*Y.(S_v)^2)/(exp(2*Z)) + (9*S^2.*Y.^2*(S_v)^2)/(8*\exp(6*Z)) ... \\
& - (3*S^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z)) + (11*S^2.*Y.^2*(S_v)^2)/(2*\exp(4*Z)) - \\
& (7*S^2.*Y.^2*(S_v)^2)/(2*\exp(3*Z)) + (15*S^2.*Y.^2*(S_v)^2)/(8*\exp(2*Z)) ... \\
& + (\exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v)^2)/2 + \exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v)^2 - \\
& (3*S^2.*Y.^3*(S_v)^2)/(exp(4*Z)) + (4*S^2.*Y.^3*(S_v)^2)/(exp(3*Z)) ... \\
& - (S^2.*Y.^3*(S_v)^2)/(exp(2*Z)) + (9*S^2.*Y.^4*(S_v)^2)/(16*\exp(6*Z)) - \\
& (3*S^2.*Y.^4*(S_v)^2)/(2*\exp(5*Z)) + (11*S^2.*Y.^4*(S_v)^2)/(8*\exp(4*Z)) ... \\
& - (S^2.*Y.^4*(S_v)^2)/(2*\exp(3*Z)) + (S^2.*Y.^4*(S_v)^2)/(16*\exp(2*Z)) + \\
& (9*S^2*(S_v)^2)/(4*\exp(6*Z)*Z^4) - (6*S^2*(S_v)^2)/(exp(5*Z)*Z^4) ... \\
& + (11*S^2*(S_v)^2)/(2*\exp(4*Z)*Z^4) - (2*S^2*(S_v)^2)/(exp(3*Z)*Z^4) + \\
& (S^2*(S_v)^2)/(4*\exp(2*Z)*Z^4) + (S^2*(S_v)^2)/(4*\exp(2.*Y.*Z)*Z^4) ... \\
& + (9*\exp(-4*Z - 2.*Y.*Z)*S^2*(S_v)^2)/(4*Z^4) - (6*\exp(-3*Z - 2.*Y.*Z)*S^2*(S_v)^2)/Z^4 + \\
& (11*\exp(-2*Z - 2.*Y.*Z)*S^2*(S_v)^2)/(2*Z^4) ... \\
& - (2*\exp(-Z - 2.*Y.*Z)*S^2*(S_v)^2)/Z^4 - (9*\exp(-5*Z - Y.*Z)*S^2*(S_v)^2)/(2*Z^4) + (12*\exp(- \\
& 4*Z - Y.*Z)*S^2*(S_v)^2)/Z^4 - (11*\exp(-3*Z - Y.*Z)*S^2*(S_v)^2)/Z^4 ...
\end{aligned}$$

$$\begin{aligned}
& + (4*\exp(-2*Z) - Y.*Z)*S^2*(S_v)^2)/Z^4 - (\exp(-Z) - Y.*Z)*S^2*(S_v)^2)/(2*Z^4) + \\
& (12*S^2*(S_v)^2)/(\exp(5*Z)*Z^3) - (22*S^2*(S_v)^2)/(\exp(4*Z)*Z^3) \\
& + (27*S^2*(S_v)^2)/(2*\exp(3*Z)*Z^3) - (4*S^2*(S_v)^2)/(\exp(2*Z)*Z^3) \\
& (S^2*(S_v)^2)/(2*\exp(Z)*Z^3) - (S^2*(S_v)^2)/(2*\exp(3.*Y.*Z)*Z^3) ... \\
& - (S^2*(S_v)^2)/(2*\exp(Y.*Z)*Z^3) - (3*\exp(-2*Z) - 3.*Y.*Z)*S^2*(S_v)^2)/(2*Z^3) + (2*\exp(-Z) - \\
& 3.*Y.*Z)*S^2*(S_v)^2)/Z^3 - (3*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v)^2)/(2*Z^3) ... \\
& + (2*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v)^2)/Z^3 - (\exp(-Z) - 2.*Y.*Z)*S^2*(S_v)^2)/(2*Z^3) - (9*\exp(-4*Z) \\
& - Y.*Z)*S^2*(S_v)^2)/Z^3 + (18*\exp(-3*Z) - Y.*Z)*S^2*(S_v)^2)/Z^3 ... \\
& - (25*\exp(-2*Z) - Y.*Z)*S^2*(S_v)^2)/(2*Z^3) + (4*\exp(-Z) - Y.*Z)*S^2*(S_v)^2)/Z^3 - \\
& (9*S^2.*Y.(S_v)^2)/(2*\exp(5*Z)*Z^3) + (12*S^2.*Y.(S_v)^2)/(2*\exp(4*Z)*Z^3) ... \\
& - (11*S^2.*Y.(S_v)^2)/(2*\exp(3*Z)*Z^3) + (4*S^2.*Y.(S_v)^2)/(2*\exp(2*Z)*Z^3) \\
& (S^2.*Y.(S_v)^2)/(2*\exp(Z)*Z^3) + (S^2.*Y.(S_v)^2)/(2*\exp(Y.*Z)*Z^3) ... \\
& + (9*\exp(-4*Z) - Y.*Z)*S^2.*Y.(S_v)^2)/(2*Z^3) - (12*\exp(-3*Z) - Y.*Z)*S^2.*Y.(S_v)^2)/Z^3 + \\
& (11*\exp(-2*Z) - Y.*Z)*S^2.*Y.(S_v)^2)/Z^3 ... \\
& - (4*\exp(-Z) - Y.*Z)*S^2.*Y.(S_v)^2)/Z^3 + (S^2*(S_v)^2)/(4*Z^2) \\
& (9*S^2*(S_v)^2)/(4*\exp(6*Z)*Z^2) - (3*S^2*(S_v)^2)/(exp(5*Z)*Z^2) \\
& (19*S^2*(S_v)^2)/(exp(4*Z)*Z^2) ... \\
& - (19*S^2*(S_v)^2)/(exp(3*Z)*Z^2) + (35*S^2*(S_v)^2)/(4*\exp(2*Z)*Z^2) \\
& (2*S^2*(S_v)^2)/(exp(Z)*Z^2) + (S^2*(S_v)^2)/(4*\exp(4.*Y.*Z)*Z^2) ... \\
& + (S^2*(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2) + (\exp(-Z) - 3.*Y.*Z)*S^2*(S_v)^2)/Z^2 + (5*\exp(-2*Z) - \\
& 2.*Y.*Z)*S^2*(S_v)^2)/Z^2 - (2*\exp(-Z) - 2.*Y.*Z)*S^2*(S_v)^2)/Z^2 ... \\
& - (9*\exp(-5*Z) - Y.*Z)*S^2*(S_v)^2)/(4*Z^2) + (3*\exp(-4*Z) - Y.*Z)*S^2*(S_v)^2)/Z^2 + (5*\exp(-3*Z) \\
& - Y.*Z)*S^2*(S_v)^2)/Z^2 - (\exp(-2*Z) - Y.*Z)*S^2*(S_v)^2)/Z^2 ... \\
& + (\exp(-Z) - Y.*Z)*S^2*(S_v)^2)/(4*Z^2) - (S^2.*Y.(S_v)^2)/(2*Z^2) \\
& (15*S^2.*Y.(S_v)^2)/(exp(4*Z)*Z^2) + (26*S^2.*Y.(S_v)^2)/(exp(3*Z)*Z^2) ... \\
& - (29*S^2.*Y.(S_v)^2)/(2*\exp(2*Z)*Z^2) + (4*S^2.*Y.(S_v)^2)/(exp(Z)*Z^2) \\
& (S^2.*Y.(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2) - (3*\exp(-2*Z) - 2.*Y.*Z)*S^2.*Y.(S_v)^2)/(2*Z^2) ... \\
& + (2*\exp(-Z) - 2.*Y.*Z)*S^2.*Y.(S_v)^2)/Z^2 + (S^2.*Y.^2*(S_v)^2)/(4*Z^2) \\
& (9*S^2.*Y.^2*(S_v)^2)/(4*\exp(6*Z)*Z^2) - (6*S^2.*Y.^2*(S_v)^2)/(exp(5*Z)*Z^2) ... \\
& + (31*S^2.*Y.^2*(S_v)^2)/(4*\exp(4*Z)*Z^2) - (8*S^2.*Y.^2*(S_v)^2)/(exp(3*Z)*Z^2) \\
& (23*S^2.*Y.^2*(S_v)^2)/(4*\exp(2*Z)*Z^2) - (2*S^2.*Y.^2*(S_v)^2)/(exp(Z)*Z^2) ... \\
& - (9*\exp(-5*Z) - Y.*Z)*S^2.*Y.^2*(S_v)^2)/(4*Z^2) + (6*\exp(-4*Z) - Y.*Z)*S^2.*Y.^2*(S_v)^2)/Z^2 - \\
& (11*\exp(-3*Z) - Y.*Z)*S^2.*Y.^2*(S_v)^2)/(2*Z^2) ... \\
& + (2*\exp(-2*Z) - Y.*Z)*S^2.*Y.^2*(S_v)^2)/Z^2 - (\exp(-Z) - Y.*Z)*S^2.*Y.^2*(S_v)^2)/(4*Z^2) + \\
& (9*S^2*(S_v)^2)/(2*\exp(5*Z)*Z) - (S^2*(S_v)^2)/(exp(4*Z)*Z) ... \\
& + (25*S^2*(S_v)^2)/(4*\exp(3*Z)*Z) - (3*S^2*(S_v)^2)/(exp(2*Z)*Z) + (3*S^2*(S_v)^2)/(4*\exp(Z)*Z) \\
& + (3*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v)^2)/(4*Z) ... \\
& + (3*\exp(-Z) - 2.*Y.*Z)*S^2*(S_v)^2)/(4*Z) + (3*\exp(-4*Z) - Y.*Z)*S^2*(S_v)^2)/Z - (2*\exp(-3*Z) - \\
& Y.*Z)*S^2*(S_v)^2)/Z + (2*\exp(-2*Z) - Y.*Z)*S^2*(S_v)^2)/Z ... \\
& - (9*S^2.*Y.(S_v)^2)/(4*\exp(5*Z)*Z) + (3*S^2.*Y.(S_v)^2)/(exp(4*Z)*Z) \\
& (11*S^2.*Y.(S_v)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.(S_v)^2)/(exp(2*Z)*Z) ... \\
& - (7*S^2.*Y.(S_v)^2)/(4*\exp(Z)*Z) - (\exp(-Z) - 2.*Y.*Z)*S^2.*Y.(S_v)^2)/Z - (2*\exp(-2*Z) - \\
& Y.*Z)*S^2.*Y.(S_v)^2)/Z + (15*S^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z)*Z) ... \\
& - (13*S^2.*Y.^2*(S_v)^2)/(exp(4*Z)*Z) + (41*S^2.*Y.^2*(S_v)^2)/(4*\exp(3*Z)*Z) \\
& (6*S^2.*Y.^2*(S_v)^2)/(exp(2*Z)*Z) + (5*S^2.*Y.^2*(S_v)^2)/(4*\exp(Z)*Z) ... \\
& + (3*\exp(-3*Z) - 2.*Y.*Z)*S^2.*Y.^2*(S_v)^2)/(4*Z) - (\exp(-2*Z) - 2.*Y.*Z)*S^2.*Y.^2*(S_v)^2)/Z + \\
& (\exp(-Z) - 2.*Y.*Z)*S^2.*Y.^2*(S_v)^2)/(4*Z) ... \\
& - (9*S^2.*Y.^3*(S_v)^2)/(4*\exp(5*Z)*Z) + (6*S^2.*Y.^3*(S_v)^2)/(exp(4*Z)*Z) \\
& (11*S^2.*Y.^3*(S_v)^2)/(2*\exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v)^2)/(exp(2*Z)*Z) ... \\
& - (S^2.*Y.^3*(S_v)^2)/(4*\exp(Z)*Z) - (3*S^2.*Z*(S_v)^2)/(4*\exp(5*Z)) \\
& (3*S^2.*Z*(S_v)^2)/(4*\exp(3*Z)) + (S^2.*Y.*Z*(S_v)^2)/exp(3*Z) + (S^2.*Y.^2*Z*(S_v)^2)/exp(4*Z) ... \\
& + (S^2.*Y.^2*Z*(S_v)^2)/(2*\exp(3*Z)) - (S^2.*Y.^3*Z*(S_v)^2)/exp(3*Z) \\
& (3*S^2.*Y.^4*Z*(S_v)^2)/(4*\exp(5*Z)) - (S^2.*Y.^4*Z*(S_v)^2)/exp(4*Z) ... \\
& + (S^2.*Y.^4*Z*(S_v)^2)/(4*\exp(3*Z)) + (S^2.*Z^2*(S_v)^2)/(4*\exp(4*Z)) \\
& (S^2.*Y.^2*Z^2*(S_v)^2)/(2*\exp(4*Z)) + (S^2.*Y.^4*Z^2*(S_v)^2)/(4*\exp(4*Z));
\end{aligned}$$

```

Pe1=2;
Nc1=[1./Pe1^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Ns1=Nf+Nc1+Ny;
Phi1=Nf./[Nc1+Ny];
Be1=1./[1+Phi1];
Gf1=Nf./Ns1;
Gh1=[Nc1+Ny]./Ns1;
Nh1=Nc1+Ny;

```

```

Pe2=4;
Nc2=[1./Pe2^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Ns2=Nf+Nc2+Ny;
Phi2=Nf./[Nc2+Ny];
Be2=1./[1+Phi2];
Gf2=Nf./Ns2;
Gh2=[Nc2+Ny]./Ns2;
Nh2=Nc2+Ny;

```

```

Pe3=6;
Nc3=[1./Pe3^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Ns3=Nf+Nc3+Ny;
Phi3=Nf./[Nc3+Ny];
Be3=1./[1+Phi3];
Gf3=Nf./Ns3;
Gh3=[Nc3+Ny]./Ns3;
Nh3=Nc3+Ny;

```

```

Pe4=8;
Nc4=[1./Pe4^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Ns4=Nf+Nc4+Ny;
Phi4=Nf./[Nc4+Ny];
Be4=1./[1+Phi4];
Gf4=Nf./Ns4;
Gh4=[Nc4+Ny]./Ns4;
Nh4=Nc4+Ny;

```

```

Pe5=10;
Nc5=[1./Pe5^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Ns5=Nf+Nc5+Ny;
Phi5=Nf./[Nc5+Ny];
Be5=1./[1+Phi5];
Gf5=Nf./Ns5;
Gh5=[Nc5+Ny]./Ns5;
Nh5=Nc5+Ny;

```

```

plot(Y,Ns1,'b',Y,Ns2,'g',Y,Ns3,'r',Y,Ns4,'k',Y,Ns5,'m')
% plot(Y,Be1,'b',Y,Be2,'g',Y,Be3,'r',Y,Be4,'k',Y,Be5,'m')
% plot(Y,Phi1,'b',Y,Phi2,'g',Y,Phi3,'r',Y,Phi4,'k',Y,Phi5,'m')

```

```
% plot(Y,Gf1,'b',Y,Gf2,'g',Y,Gf3,'r',Y,Gf4,'k',Y,Gf5,'m')  
% plot(Y,Gh1,'b',Y,Gh2,'g',Y,Gh3,'r',Y,Gh4,'k',Y,Gh5,'m')  
% plot(Y,Nc1,'b',Y,Nc2,'g',Y,Nc3,'r',Y,Nc4,'k',Y,Nc5,'m')  
% plot(Y,Nh1,'b',Y,Nh2,'g',Y,Nh3,'r',Y,Nh4,'k',Y,Nh5,'m')  
% plot(Nh1,Nf,'b',Nh2,Nf,'g',Nh3,Nf,'r',Nh4,Nf,'k',Nh5,Nf,'m')
```

PLOTTOOLS ON

**1.4. Distribution of  $N_s$ ,  $Be$ ,  $\Phi$ ,  $G_F$ ,  $G_H$ ,  $N_F$  and  $N_H$  versus  $Y$  for a range of  $S$  and set of  $S_v$ ,  $Z$ ,  $Br$  &  $Pe$**

```

S_v=1; Z=1; Br=1; Pe=2.5;
% S_v=2.5; Z=3.5; Br=0.5; Pe=5;

% % % % Z=2.5; S_v=3; Br=0.6; Pe=1;
% % % % Z=7.5; S_v=15; Br=0.6; Pe=2.5;
% % % % Z=5; S_v=0.75; Br=1; Pe=2;
% % % % Z=18; S_v=25; Br=0.9; Pe=5;

q=1.86;
s=1;
Dh=250*10^-6;
Y=0:0.005:1;

Nc=[1/Pe^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Nf=Br*[(Z^2).*exp(-2.*Y.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-Y.*Z)];
```

S1=1;

Ny1=1 - exp(-2\*Z) + exp(-Z - Y.\*Z) - (2\*S1)/exp(2\*Z) + 2\*exp(-Z - Y.\*Z)\*S1 - S1^2/exp(2\*Z) + exp(-Z - Y.\*Z)\*S1^2 - 2.\*Y + Y.^2 + Y.^2/exp(2\*Z) - exp(-Z - Y.\*Z).\*Y.^2 ...  
+ (2\*S1.\*Y.^2)/exp(2\*Z) - 2\*exp(-Z - Y.\*Z)\*S1.\*Y.^2 + (S1^2.\*Y.^2)/exp(2\*Z) - exp(-Z - Y.\*Z)\*S1^2.\*Y.^2 + 1/(exp(2\*Z)\*Z^2) + 1./(exp(2.\*Y.\*Z)\*Z^2) ...  
- (2\*exp(-Z - Y.\*Z))/Z^2 + (2\*S1)/(exp(2\*Z)\*Z^2) + (2\*S1)./(exp(2.\*Y.\*Z)\*Z^2) - (4\*exp(-Z - Y.\*Z)\*S1)/Z^2 + S1^2/(exp(2\*Z)\*Z^2) + S1^2.)/(exp(2.\*Y.\*Z)\*Z^2) ...  
- (2\*exp(-Z - Y.\*Z)\*S1^2)/Z^2 + 2/(exp(Z)\*Z) - 2./((exp(Y.\*Z)\*Z) + (2\*S1)/(exp(Z)\*Z) - (2\*S1)./(exp(Y.\*Z)\*Z) - (2.\*Y)/(exp(Z)\*Z) + (2.\*Y)/(exp(Y.\*Z)\*Z) ...  
- (2\*S1.\*Y)/(exp(Z)\*Z) + (2\*S1.\*Y)/(exp(Y.\*Z)\*Z) - Z/exp(Z) - (S1\*Z)/exp(Z) + (Y.\*Z)/exp(Z) + (S1.\*Y.\*Z)/exp(Z) + (Y.^2\*Z)/exp(Z) + (S1.\*Y.^2\*Z)/exp(Z) - (Y.^3\*Z)/exp(Z) ...  
- (S1.\*Y.^3\*Z)/exp(Z) + Z^2/(4\*exp(2\*Z)) + (S1\*Z^2)/(2\*exp(2\*Z)) + (S1^2\*Z^2)/(4\*exp(2\*Z)) - (Y.^2\*Z^2)/(2\*exp(2\*Z)) - (S1.\*Y.^2\*Z^2)/exp(2\*Z) ...  
- (S1^2.\*Y.^2\*Z^2)/(2\*exp(2\*Z)) + (Y.^4\*Z^2)/(4\*exp(2\*Z)) + (S1.\*Y.^4\*Z^2)/(2\*exp(2\*Z)) + (S1^2.\*Y.^4\*Z^2)/(4\*exp(2\*Z)) - (7\*S1\*(S\_v))/(2\*exp(3\*Z)) ...  
+ (2\*S1\*(S\_v))/exp(2\*Z) + (S1\*(S\_v))/exp(Z) - (exp(-Z - 2.\*Y.\*Z)\*S1\*(S\_v))/2 - (5\*S1^2\*(S\_v))/exp(3\*Z) + (2\*S1^2\*(S\_v))/exp(2\*Z) - (S1^2\*(S\_v))/(2\*exp(Z)) ...  
- (exp(-Z - 2.\*Y.\*Z)\*S1^2\*(S\_v))/2 - (2\*S1.\*Y.(S\_v))/exp(2\*Z) - (3\*S1.\*Y.(S\_v))/exp(Z) + (3\*S1^2.\*Y.(S\_v))/(2\*exp(3\*Z)) - (2\*S1^2.\*Y.(S\_v))/exp(2\*Z) ...  
+ (S1^2.\*Y.(S\_v))/(2\*exp(Z)) + (13\*S1.\*Y.^2\*(S\_v))/(2\*exp(3\*Z)) - (4\*S1.\*Y.^2\*(S\_v))/exp(2\*Z) + (3\*S1.\*Y.^2\*(S\_v))/exp(Z) + (exp(-Z - 2.\*Y.\*Z)\*S1^2.\*Y.^2\*(S\_v))/2 - (3\*S1.\*Y.^3\*(S\_v))/exp(3\*Z) ...  
+ (5\*S1^2.\*Y.^2\*(S\_v))/exp(3\*Z) - (2\*S1^2.\*Y.^2\*(S\_v))/exp(2\*Z) + (S1^2.\*Y.^2\*(S\_v))/(2\*exp(Z)) + (exp(-Z - 2.\*Y.\*Z)\*S1^2.\*Y.^2\*(S\_v))/2 - (3\*S1.\*Y.^3\*(S\_v))/exp(3\*Z) ...  
+ (4\*S1.\*Y.^3\*(S\_v))/exp(2\*Z) - (S1.\*Y.^3\*(S\_v))/exp(Z) - (3\*S1^2.\*Y.^3\*(S\_v))/(2\*exp(3\*Z)) + (2\*S1^2.\*Y.^3\*(S\_v))/exp(2\*Z) - (S1^2.\*Y.^3\*(S\_v))/(2\*exp(Z)) ...  
+ (3\*S1\*(S\_v))/(exp(4\*Z)\*Z^3) - (4\*S1\*(S\_v))/(exp(3\*Z)\*Z^3) + (S1\*(S\_v))/(exp(2\*Z)\*Z^3) + (S1\*(S\_v))./(exp(2.\*Y.\*Z)\*Z^3) + (3\*exp(-2\*Z - 2.\*Y.\*Z)\*S1\*(S\_v))/Z^3 ...  
- (4\*exp(-Z - 2.\*Y.\*Z)\*S1\*(S\_v))/Z^3 - (6\*exp(-3\*Z - Y.\*Z)\*S1\*(S\_v))/Z^3 + (8\*exp(-2\*Z - Y.\*Z)\*S1\*(S\_v))/Z^3 - (2\*exp(-Z - Y.\*Z)\*S1\*(S\_v))/Z^3 ...

$$\begin{aligned}
& + (3*S1^2*(S_v))/(exp(4*Z)*Z^3) - (4*S1^2*(S_v))/(exp(3*Z)*Z^3) + (S1^2*(S_v))/(exp(2*Z)*Z^3) + \\
& (S1^2*(S_v))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S1^2*(S_v))/Z^3 ... \\
& - (4*exp(-Z - 2.*Y.*Z)*S1^2*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S1^2*(S_v))/Z^3 + (8*exp(-2*Z - \\
& Y.*Z)*S1^2*(S_v))/Z^3 - (2*exp(-Z - Y.*Z)*S1^2*(S_v))/Z^3 ... \\
& + (11*S1*(S_v))/(exp(3*Z)*Z^2) - (8*S1*(S_v))/(exp(2*Z)*Z^2) + (2*S1*(S_v))/(exp(Z)*Z^2) - \\
& (S1*(S_v))./(exp(3.*Y.*Z)*Z^2) - (2*S1*(S_v))./(exp(Y.*Z)*Z^2) ... \\
& - (exp(-Z - 2.*Y.*Z)*S1*(S_v))/Z^2 - (9*exp(-2*Z - Y.*Z)*S1*(S_v))/Z^2 + (8*exp(-Z - \\
& Y.*Z)*S1*(S_v))/Z^2 + (8*S1^2*(S_v))/(exp(3*Z)*Z^2); ... \\
& - (4*S1^2*(S_v))/(exp(2*Z)*Z^2) + (S1^2*(S_v))/(exp(Z)*Z^2) - (S1^2*(S_v))./(exp(3.*Y.*Z)*Z^2) - \\
& (S1^2*(S_v))./(exp(Y.*Z)*Z^2) - (exp(-Z - 2.*Y.*Z)*S1^2*(S_v))/Z^2 ... \\
& - (6*exp(-2*Z - Y.*Z)*S1^2*(S_v))/Z^2 + (4*exp(-Z - Y.*Z)*S1^2*(S_v))/Z^2 - \\
& (6*S1.*Y.^(S_v))/(exp(3*Z)*Z^2) + (8*S1.*Y.^(S_v))/(exp(2*Z)*Z^2) ... \\
& - (2*S1.*Y.^(S_v))/(exp(Z)*Z^2) + (2*S1.*Y.^(S_v))/(exp(Y.*Z)*Z^2) + (6*exp(-2*Z - \\
& Y.*Z)*S1.*Y.^(S_v))/Z^2 - (8*exp(-Z - Y.*Z)*S1.*Y.^(S_v))/Z^2 ... \\
& - (3*S1^2.*Y.^(S_v))/(exp(3*Z)*Z^2) + (4*S1^2.*Y.^(S_v))/(exp(2*Z)*Z^2) - \\
& (S1^2.*Y.^(S_v))/(exp(Z)*Z^2) + (S1^2.*Y.^(S_v))/(exp(Y.*Z)*Z^2) ... \\
& + (3*exp(-2*Z - Y.*Z)*S1^2.*Y.^(S_v))/Z^2 - (4*exp(-Z - Y.*Z)*S1^2.*Y.^(S_v))/Z^2 + (S1*(S_v))/Z \\
& + (2*S1*(S_v))/(exp(3*Z)*Z) + (9*S1*(S_v))/(exp(2*Z)*Z) ... \\
& - (4*S1*(S_v))/(exp(Z)*Z) + (S1*(S_v))./(exp(2.*Y.*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S1*(S_v))/Z \\
& + (exp(-Z - Y.*Z)*S1*(S_v))/Z + (2*S1^2*(S_v))/(exp(3*Z)*Z) ... \\
& + (S1^2*(S_v))/(exp(2*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S1^2*(S_v))/Z - (exp(-Z - Y.*Z)*S1^2*(S_v))/Z \\
& - (2*S1.*Y.^(S_v))/Z - (13*S1.*Y.^(S_v))/(exp(2*Z)*Z) ... \\
& + (8*S1.*Y.^(S_v))/(exp(Z)*Z) - (S1.*Y.^(S_v))./(exp(2.*Y.*Z)*Z) - \\
& (2*S1^2.*Y.^(S_v))/(exp(2*Z)*Z) + (2*exp(-Z - Y.*Z)*S1^2.*Y.^(S_v))/Z + (S1.*Y.^2*(S_v))/Z ... \\
& + (3*S1.*Y.^2*(S_v))/(exp(4*Z)*Z) - (4*S1.*Y.^2*(S_v))/(exp(3*Z)*Z) + \\
& (4*S1.*Y.^2*(S_v))/(exp(2*Z)*Z) - (4*S1.*Y.^2*(S_v))/(exp(Z)*Z) ... \\
& - (3*exp(-3*Z - Y.*Z)*S1.*Y.^2*(S_v))/Z + (4*exp(-2*Z - Y.*Z)*S1.*Y.^2*(S_v))/Z - (exp(-Z - \\
& Y.*Z)*S1.*Y.^2*(S_v))/Z + (3*S1^2.*Y.^2*(S_v))/(exp(4*Z)*Z) ... \\
& - (4*S1^2.*Y.^2*(S_v))/(exp(3*Z)*Z) + (S1^2.*Y.^2*(S_v))/(exp(2*Z)*Z) - (3*exp(-3*Z - \\
& Y.*Z)*S1^2.*Y.^2*(S_v))/Z + (4*exp(-2*Z - Y.*Z)*S1^2.*Y.^2*(S_v))/Z ... \\
& - (exp(-Z - Y.*Z)*S1^2.*Y.^2*(S_v))/Z - (3*S1^2.*Y.^2*(S_v))/(4*exp(4*Z)) - (7*S1^2.*Z*(S_v))/(4*exp(2*Z)) \\
& - (3*S1^2.*Z*(S_v))/(4*exp(4*Z)) - (3*S1^2.*Z*(S_v))/(4*exp(2*Z)) ... \\
& + (2*S1.*Y.^2*(S_v))/(exp(2*Z) + (S1^2.*Y.^2*(S_v))/(exp(2*Z) + (S1.*Y.^2*(S_v))/exp(3*Z) + \\
& (3*S1.*Y.^2*(S_v))/(2*exp(2*Z)) + (S1^2.*Y.^2*(S_v))/(exp(3*Z) ... \\
& + (S1^2.*Y.^2*(S_v))/(2*exp(2*Z)) - (2*S1.*Y.^3*(S_v))/exp(2*Z) - \\
& (S1^2.*Y.^3*(S_v))/exp(2*Z) + (3*S1.*Y.^4*(S_v))/(4*exp(4*Z)) - (S1.*Y.^4*(S_v))/exp(3*Z) \\
& ... \\
& + (S1.*Y.^4*(S_v))/(4*exp(2*Z)) + (3*S1^2.*Y.^4*(S_v))/(4*exp(4*Z)) - \\
& (S1^2.*Y.^4*(S_v))/exp(3*Z) + (S1^2.*Y.^4*(S_v))/(4*exp(2*Z)) + (S1^2.*Z*(S_v))/(2*exp(3*Z)) \\
& ... \\
& + (S1^2.*Z*(S_v))/(2*exp(3*Z)) - (S1.*Y.^2*(S_v))/exp(3*Z) - \\
& (S1^2.*Y.^2*(S_v))/exp(3*Z) + (S1.*Y.^4*(S_v))/exp(3*Z) ... \\
& + (S1^2.*Y.^4*(S_v))/exp(3*Z) + (9*S1^2*(S_v)^2)/(16*exp(6*Z)) - \\
& (23*S1^2*(S_v)^2)/(8*exp(4*Z)) + (2*S1^2*(S_v)^2)/exp(3*Z) + (S1^2*(S_v)^2)/(16*exp(2*Z)) ... \\
& - (exp(-2*Z - 2.*Y.*Z)*S1^2*(S_v)^2)/2 - exp(-3*Z - Y.*Z)*S1^2*(S_v)^2 - \\
& (2*S1^2.*Y.^(S_v)^2)/exp(3*Z) - (S1^2.*Y.^(S_v)^2)/exp(2*Z) + (9*S1^2.*Y.^2*(S_v)^2)/(8*exp(6*Z)) \\
& ... \\
& - (3*S1^2.*Y.^2*(S_v)^2)/(2*exp(5*Z)) + (11*S1^2.*Y.^2*(S_v)^2)/(2*exp(4*Z)) - \\
& (7*S1^2.*Y.^2*(S_v)^2)/(2*exp(3*Z)) + (15*S1^2.*Y.^2*(S_v)^2)/(8*exp(2*Z)) ... \\
& + (exp(-2*Z - 2.*Y.*Z)*S1^2.*Y.^2*(S_v)^2)/2 + exp(-3*Z - Y.*Z)*S1^2.*Y.^2*(S_v)^2 - \\
& (3*S1^2.*Y.^3*(S_v)^2)/exp(4*Z) + (4*S1^2.*Y.^3*(S_v)^2)/exp(3*Z) ... \\
& - (S1^2.*Y.^3*(S_v)^2)/exp(2*Z) + (9*S1^2.*Y.^4*(S_v)^2)/(16*exp(6*Z)) - \\
& (3*S1^2.*Y.^4*(S_v)^2)/(2*exp(5*Z)) + (11*S1^2.*Y.^4*(S_v)^2)/(8*exp(4*Z)) ... \\
& - (S1^2.*Y.^4*(S_v)^2)/(2*exp(3*Z)) + (S1^2.*Y.^4*(S_v)^2)/(16*exp(2*Z)) + \\
& (9*S1^2*(S_v)^2)/(4*exp(6*Z)*Z^4) - (6*S1^2*(S_v)^2)/(exp(5*Z)*Z^4) ...
\end{aligned}$$

$$\begin{aligned}
& + \frac{(11*S1^2*(S_v)^2)/(2*\exp(4*Z)*Z^4)}{(S1^2*(S_v)^2)/(4*\exp(2*Z)*Z^4) + (S1^2*(S_v)^2)./(4*\exp(2.*Y.*Z)*Z^4)} - \frac{(2*S1^2*(S_v)^2)/(\exp(3*Z)*Z^4)}{(2.*Y.*Z)*S1^2*(S_v)^2)./(4*\exp(2.*Y.*Z)*Z^4)} + \\
& + \frac{(9*\exp(-4*Z - 2.*Y.*Z)*S1^2*(S_v)^2)/(4*Z^4)}{(6*\exp(-3*Z - 2.*Y.*Z)*S1^2*(S_v)^2)/Z^4} + \frac{(11*\exp(-2*Z - 2.*Y.*Z)*S1^2*(S_v)^2)/(2*Z^4)}{(2*exp(-Z - 2.*Y.*Z)*S1^2*(S_v)^2)/Z^4} - \\
& - \frac{(2*exp(-5*Z - Y.*Z)*S1^2*(S_v)^2)/(2*Z^4)}{(9*exp(-3*Z - Y.*Z)*S1^2*(S_v)^2)/Z^4} + \frac{(12*exp(-4*Z - Y.*Z)*S1^2*(S_v)^2)/(2*Z^4)}{(11*exp(-3*Z - Y.*Z)*S1^2*(S_v)^2)/Z^4} + \\
& + \frac{(4*exp(-2*Z - Y.*Z)*S1^2*(S_v)^2)/(Z^4)}{(exp(-Z - Y.*Z)*S1^2*(S_v)^2)/(2*Z^4)} - \frac{(exp(-Z - Y.*Z)*S1^2*(S_v)^2)/(2*Z^4)}{(12*S1^2*(S_v)^2)./(exp(5*Z)*Z^3)} + \frac{(22*S1^2*(S_v)^2)/(exp(4*Z)*Z^3)}{(12*S1^2*(S_v)^2)/(exp(5*Z)*Z^3)} + \\
& + \frac{(27*S1^2*(S_v)^2)/(2*exp(3*Z)*Z^3)}{(S1^2*(S_v)^2)/(2*exp(Z)*Z^3)} - \frac{(4*S1^2*(S_v)^2)/(exp(2*Z)*Z^3)}{(S1^2*(S_v)^2)./(2*exp(3.*Y.*Z)*Z^3)} + \\
& - \frac{(S1^2*(S_v)^2)./(2*exp(Y.*Z)*Z^3)}{(3*exp(-2*Z - 3.*Y.*Z)*S1^2*(S_v)^2)/(2*Z^3)} + \frac{(2*exp(-Z - 3.*Y.*Z)*S1^2*(S_v)^2)/(Z^3)}{(3*exp(-3*Z - 2.*Y.*Z)*S1^2*(S_v)^2)/(2*Z^3)} + \\
& + \frac{(2*exp(-2*Z - 2.*Y.*Z)*S1^2*(S_v)^2)/(Z^3)}{(exp(-Z - 2.*Y.*Z)*S1^2*(S_v)^2)/(2*Z^3)} - \frac{(9*exp(-4*Z - Y.*Z)*S1^2*(S_v)^2)/(Z^3)}{(4*exp(-2*Z - Y.*Z)*S1^2*(S_v)^2)/(Z^3)} + \\
& - \frac{(25*exp(-2*Z - Y.*Z)*S1^2*(S_v)^2)/(2*Z^3)}{(9*S1^2*(S_v)^2)./(2*exp(5*Z)*Z^3)} + \frac{(12*S1^2.*Y.(S_v)^2)/(exp(4*Z)*Z^3)}{(12*S1^2*(S_v)^2)/(exp(5*Z)*Z^3)} ... \\
& - \frac{(11*S1^2.*Y.(S_v)^2)/(exp(3*Z)*Z^3)}{(S1^2.*Y.(S_v)^2)./(2*exp(Z)*Z^3)} + \frac{(4*S1^2.*Y.(S_v)^2)/(exp(2*Z)*Z^3)}{(S1^2.*Y.(S_v)^2)./(2*exp(Y.*Z)*Z^3)} ... \\
& + \frac{(9*exp(-4*Z - Y.*Z)*S1^2.*Y.(S_v)^2)/(2*Z^3)}{(12*exp(-3*Z - Y.*Z)*S1^2.*Y.(S_v)^2)/(Z^3)} + \frac{(11*exp(-2*Z - Y.*Z)*S1^2.*Y.(S_v)^2)/(Z^3)}{(11*exp(-2*Z - Y.*Z)*S1^2.*Y.(S_v)^2)/Z^3} ... \\
& - \frac{(4*exp(-Z - Y.*Z)*S1^2.*Y.(S_v)^2)/(Z^3)}{(9*S1^2*(S_v)^2)/(4*exp(6*Z)*Z^2)} + \frac{(S1^2.*Y.(S_v)^2)/(exp(5*Z)*Z^2)}{(3*S1^2*(S_v)^2)/(exp(5*Z)*Z^2)} + \\
& (19*S1^2*(S_v)^2)/(exp(4*Z)*Z^2) ... \\
& - \frac{(19*S1^2*(S_v)^2)/(exp(3*Z)*Z^2)}{(2*S1^2*(S_v)^2)/(exp(Z)*Z^2)} + \frac{(35*S1^2*(S_v)^2)/(4*exp(2*Z)*Z^2)}{(S1^2*(S_v)^2)./(2*exp(4.*Y.*Z)*Z^2)} ... \\
& + \frac{(S1^2*(S_v)^2)./(2*exp(2.*Y.*Z)*Z^2)}{(exp(-Z - 3.*Y.*Z)*S1^2*(S_v)^2)/Z^2} + \frac{(5*exp(-2*Z - 2.*Y.*Z)*S1^2*(S_v)^2)/Z^2}{(2*exp(-Z - 2.*Y.*Z)*S1^2*(S_v)^2)/Z^2} ... \\
& - \frac{(9*exp(-5*Z - Y.*Z)*S1^2*(S_v)^2)/(4*Z^2)}{(3*exp(-4*Z - Y.*Z)*S1^2*(S_v)^2)/Z^2} + \frac{(5*exp(-3*Z - Y.*Z)*S1^2*(S_v)^2)/Z^2}{(9*exp(-5*Z - Y.*Z)*S1^2*(S_v)^2)/Z^2} ... \\
& + \frac{(exp(-Z - Y.*Z)*S1^2*(S_v)^2)/(4*Z^2)}{(15*S1^2.*Y.(S_v)^2)/(exp(4*Z)*Z^2)} - \frac{(S1^2.*Y.(S_v)^2)/(exp(3*Z)*Z^2)}{(26*S1^2.*Y.(S_v)^2)/(exp(3*Z)*Z^2)} ... \\
& - \frac{(29*S1^2.*Y.(S_v)^2)/(2*exp(2*Z)*Z^2)}{(S1^2.*Y.(S_v)^2)./(2*exp(2.*Y.*Z)*Z^2)} + \frac{(4*S1^2.*Y.(S_v)^2)/(exp(Z)*Z^2)}{(3*exp(-2*Z - 2.*Y.*Z)*S1^2.*Y.(S_v)^2)/(2*Z^2)} ... \\
& + \frac{(2*exp(-Z - 2.*Y.*Z)*S1^2.*Y.(S_v)^2)/(Z^2)}{(9*S1^2.*Y.(S_v)^2)./(4*exp(6*Z)*Z^2)} - \frac{(6*S1^2.*Y.^2*(S_v)^2)/(exp(5*Z)*Z^2)}{(6*S1^2.*Y.^2*(S_v)^2)/(exp(5*Z)*Z^2)} ... \\
& + \frac{(31*S1^2.*Y.^2*(S_v)^2)/(4*exp(4*Z)*Z^2)}{(23*S1^2.*Y.^2*(S_v)^2)/(4*exp(2*Z)*Z^2)} - \frac{(8*S1^2.*Y.^2*(S_v)^2)/(exp(3*Z)*Z^2)}{(2*S1^2.*Y.^2*(S_v)^2)/(exp(Z)*Z^2)} ... \\
& - \frac{(9*exp(-5*Z - Y.*Z)*S1^2.*Y.^2*(S_v)^2)/(4*Z^2)}{(6*exp(-4*Z - Y.*Z)*S1^2.*Y.^2*(S_v)^2)/Z^2} + \frac{(6*exp(-4*Z - Y.*Z)*S1^2.*Y.^2*(S_v)^2)/(4*Z^2)}{(11*exp(-3*Z - Y.*Z)*S1^2.*Y.^2*(S_v)^2)/(2*Z^2)} ... \\
& + \frac{(2*exp(-2*Z - Y.*Z)*S1^2.*Y.^2*(S_v)^2)/(Z^2)}{(exp(-Z - Y.*Z)*S1^2.*Y.^2*(S_v)^2)/(4*Z^2)} - \frac{(exp(-Z - Y.*Z)*S1^2.*Y.^2*(S_v)^2)/(4*Z^2)}{(9*S1^2*(S_v)^2)/(2*exp(5*Z)*Z)} - \frac{(S1^2*(S_v)^2)/(exp(4*Z)*Z)}{(11*S1^2*(S_v)^2)/(exp(3*Z)*Z)} ... \\
& + \frac{(25*S1^2*(S_v)^2)/(4*exp(3*Z)*Z)}{(3*S1^2*(S_v)^2)/(4*exp(Z)*Z)} - \frac{(3*S1^2*(S_v)^2)/(exp(2*Z)*Z)}{(3*exp(-3*Z - 2.*Y.*Z)*S1^2*(S_v)^2)/(4*Z)} ... \\
& + \frac{(3*exp(-Z - 2.*Y.*Z)*S1^2*(S_v)^2)/(4*Z)}{(3*exp(-4*Z - Y.*Z)*S1^2*(S_v)^2)/Z} - \frac{(2*exp(-3*Z - Y.*Z)*S1^2*(S_v)^2)/Z}{(9*S1^2*(S_v)^2)/(4*exp(5*Z)*Z)} + \\
& \frac{(9*S1^2*(S_v)^2)/(4*exp(5*Z)*Z)}{(11*S1^2*(S_v)^2)/(exp(3*Z)*Z)} + \frac{(7*S1^2*(S_v)^2)/(exp(2*Z)*Z)}{(7*exp(-2*Z - Y.*Z)*S1^2*(S_v)^2)/Z} ... \\
& - \frac{(7*exp(-2*Z - Y.*Z)*S1^2*(S_v)^2)/(Z)}{(exp(-Z - 2.*Y.*Z)*S1^2*(S_v)^2)/Z} - \frac{(2*exp(-2*Z - Y.*Z)*S1^2*(S_v)^2)/Z}{(15*S1^2*(S_v)^2)/(2*exp(5*Z)*Z)} ... \\
& - \frac{(13*S1^2*(S_v)^2)/(exp(4*Z)*Z)}{(6*S1^2*(S_v)^2)/(exp(2*Z)*Z)} + \frac{(41*S1^2.*Y.^2*(S_v)^2)/(4*exp(3*Z)*Z)}{(5*S1^2.*Y.^2*(S_v)^2)/(4*exp(Z)*Z)} ... \\
& + \frac{(3*exp(-3*Z - 2.*Y.*Z)*S1^2.*Y.^2*(S_v)^2)/(4*Z)}{(exp(-2*Z - 2.*Y.*Z)*S1^2.*Y.^2*(S_v)^2)/Z} - \frac{(exp(-2*Z - 2.*Y.*Z)*S1^2.*Y.^2*(S_v)^2)/Z}{(exp(-Z - 2.*Y.*Z)*S1^2.*Y.^2*(S_v)^2)/(4*Z)} ... \\
& - \frac{(9*S1^2.*Y.^3*(S_v)^2)/(4*exp(5*Z)*Z)}{(11*S1^2.*Y.^3*(S_v)^2)/(2*exp(3*Z)*Z)} + \frac{(6*S1^2.*Y.^3*(S_v)^2)/(exp(4*Z)*Z)}{(2*S1^2.*Y.^3*(S_v)^2)/(exp(2*Z)*Z)} ...
\end{aligned}$$

$$\begin{aligned}
& - \frac{(S1^2.*Y.^3*(S_v)^2)/(4*\exp(Z)*Z)}{(3*S1^2*Z*(S_v)^2)/(4*\exp(3*Z))} + \frac{(3*S1^2*Z*(S_v)^2)/(4*\exp(5*Z))}{(S1^2.*Y.^2*Z*(S_v)^2)/\exp(3*Z)} \\
& (S1^2.*Y.^2*Z*(S_v)^2)/\exp(4*Z) ... \\
& + \frac{(S1^2.*Y.^2*Z*(S_v)^2)/(2*\exp(3*Z))}{(3*S1^2.*Y.^4*Z*(S_v)^2)/(4*\exp(5*Z))} - \frac{(S1^2.*Y.^4*Z*(S_v)^2)/\exp(4*Z) ...}{(S1^2.*Y.^4*Z*(S_v)^2)/(4*\exp(3*Z))} \\
& + \frac{(S1^2.*Y.^4*Z*(S_v)^2)/(4*\exp(4*Z))}{(S1^2.*Y.^2*Z^2*(S_v)^2)/(2*\exp(4*Z))} + \frac{(S1^2.*Y.^4*Z^2*(S_v)^2)/(4*\exp(4*Z))}{(S1^2.*Y.^2*Z^2*(S_v)^2)/(4*\exp(4*Z))}; 
\end{aligned}$$

```

Ns1=Nf+Nc+Ny1;
Phi1=Nf./[Nc+Ny1];
Be1=1./[1+Phi1];
Gf1=Nf./Ns1;
Gh1=[Nc+Ny1]./Ns1;
Nh1=Nc+Ny1;

```

$$\begin{aligned}
S2=2; \\
Ny2=1 - \exp(-2*Z) + \exp(-Z - Y.*Z) - (2*S2)/\exp(2*Z) + 2*\exp(-Z - Y.*Z)*S2 - S2^2/\exp(2*Z) + \exp(-Z - Y.*Z)*S2^2 - 2.*Y + Y.^2 + Y.^2/\exp(2*Z) - \exp(-Z - Y.*Z).*Y.^2 ... \\
+ (2*S2.*Y.^2)/\exp(2*Z) - 2*\exp(-Z - Y.*Z)*S2.*Y.^2 + (S2^2.*Y.^2)/\exp(2*Z) - \exp(-Z - Y.*Z)*S2^2.*Y.^2 + 1. / (\exp(2.*Y.*Z)*Z^2) ... \\
- (2*\exp(-Z - Y.*Z))/Z^2 + (2*S2)/(\exp(2*Z)*Z^2) + (2*S2)./(\exp(2.*Y.*Z)*Z^2) - (4*\exp(-Z - Y.*Z)*S2)/Z^2 + S2^2/(\exp(2.*Y.*Z)*Z^2) ... \\
- (2*\exp(-Z - Y.*Z)*S2^2)/Z^2 + 2/(\exp(Z)*Z) - 2./(\exp(Y.*Z)*Z) + (2*S2)/(\exp(Z)*Z) - (2*S2)./(\exp(Y.*Z)*Z) - (2.*Y)/(\exp(Z)*Z) + (2.*Y)/(\exp(Y.*Z)*Z) ... \\
- (2*S2.*Y)/(\exp(Z)*Z) + (2*S2.*Y)/(\exp(Y.*Z)*Z) - Z/\exp(Z) - (S2*Z)/\exp(Z) + (Y.*Z)/\exp(Z) + (S2.*Y.*Z)/\exp(Z) + (Y.^2*Z)/\exp(Z) + (S2.*Y.^2*Z)/\exp(Z) - (Y.^3*Z)/\exp(Z) ... \\
- (S2.*Y.^3*Z)/\exp(Z) + Z^2/(4*\exp(2*Z)) + (S2*Z^2)/(2*\exp(2*Z)) + (S2^2*Z^2)/(4*\exp(2*Z)) - (Y.^2*Z^2)/(2*\exp(2*Z)) - (S2.*Y.^2*Z^2)/\exp(2*Z) ... \\
- (S2^2.*Y.^2*Z^2)/(2*\exp(2*Z)) + (Y.^4*Z^2)/(4*\exp(2*Z)) + (S2.*Y.^4*Z^2)/(2*\exp(2*Z)) + (S2^2.*Y.^4*Z^2)/(4*\exp(2*Z)) - (7*S2*(S_v))/(2*\exp(3*Z)) ... \\
+ (2*S2*(S_v))/\exp(2*Z) + (S2*(S_v))/\exp(Z) - (\exp(-Z - 2.*Y.*Z)*S2*(S_v))/2 - (2*S2.*Y.*S2*(S_v))/\exp(2*Z) - (3*S2.*Y.*S2*(S_v))/\exp(Z) + (3*S2^2.*Y.*S2*(S_v))/\exp(3*Z) - (2*S2^2.*Y.*S2*(S_v))/\exp(2*Z) ... \\
- (\exp(-Z - 2.*Y.*Z)*S2^2*(S_v))/2 - (2*S2.*Y.*S2*(S_v))/\exp(2*Z) - (3*S2.*Y.*S2*(S_v))/\exp(Z) + (3*S2^2.*Y.*S2*(S_v))/\exp(3*Z) - (2*S2^2.*Y.*S2*(S_v))/\exp(2*Z) ... \\
+ (S2^2.*Y.*S2*(S_v))/\exp(2*Z) + (13*S2.*Y.^2*(S_v))/(2*\exp(3*Z)) - (4*S2.*Y.^2*(S_v))/\exp(2*Z) + (3*S2.*Y.^2*(S_v))/\exp(Z) + (\exp(-Z - 2.*Y.*Z)*S2.*Y.^2*(S_v))/2 ... \\
+ (5*S2^2.*Y.^2*(S_v))/\exp(3*Z) - (2*S2^2.*Y.^2*(S_v))/\exp(2*Z) + (S2^2.*Y.^2*(S_v))/(2*\exp(2*Z)) + (\exp(-Z - 2.*Y.*Z)*S2^2.*Y.^2*(S_v))/2 - (3*S2.*Y.^3*(S_v))/\exp(3*Z) ... \\
+ (4*S2.*Y.^3*(S_v))/\exp(2*Z) - (S2.*Y.^3*(S_v))/\exp(Z) - (3*S2^2.*Y.^3*(S_v))/(2*\exp(3*Z)) + (2*S2^2.*Y.^3*(S_v))/\exp(2*Z) - (S2^2.*Y.^3*(S_v))/(2*\exp(Z)) ... \\
+ (3*S2*(S_v))/\exp(4*Z)*Z^3) - (4*S2*(S_v))/\exp(3*Z)*Z^3) + (S2*(S_v))/\exp(2*Z)*Z^3) + (S2*(S_v))./(\exp(2.*Y.*Z)*Z^3) + (3*\exp(-2*Z - 2.*Y.*Z)*S2*(S_v))/Z^3 ... \\
- (4*\exp(-Z - 2.*Y.*Z)*S2*(S_v))/Z^3 - (6*\exp(-3*Z - Y.*Z)*S2*(S_v))/Z^3 + (8*\exp(-2*Z - Y.*Z)*S2*(S_v))/Z^3 - (2*\exp(-Z - Y.*Z)*S2*(S_v))/Z^3 ... \\
+ (3*S2^2*(S_v))/\exp(4*Z)*Z^3) - (4*S2^2*(S_v))/\exp(3*Z)*Z^3) + (S2^2*(S_v))/\exp(2*Z)*Z^3) + (S2^2*(S_v))./(\exp(2.*Y.*Z)*Z^3) + (3*\exp(-2*Z - 2.*Y.*Z)*S2^2*(S_v))/Z^3 ... \\
- (4*\exp(-Z - 2.*Y.*Z)*S2^2*(S_v))/Z^3 - (6*\exp(-3*Z - Y.*Z)*S2^2*(S_v))/Z^3 + (8*\exp(-2*Z - Y.*Z)*S2^2*(S_v))/Z^3 - (2*\exp(-Z - Y.*Z)*S2^2*(S_v))/Z^3 ... \\
+ (11*S2*(S_v))/\exp(3*Z)*Z^2) - (8*S2*(S_v))/\exp(2*Z)*Z^2) + (2*S2*(S_v))/\exp(Z)*Z^2) - (S2*(S_v))./(\exp(3.*Y.*Z)*Z^2) - (2*S2*(S_v))./(\exp(Y.*Z)*Z^2) ... \\
- (\exp(-Z - 2.*Y.*Z)*S2*(S_v))/Z^2 - (9*\exp(-2*Z - Y.*Z)*S2*(S_v))/Z^2) + (8*\exp(-Z - Y.*Z)*S2*(S_v))/Z^2 + (8*\exp(-Z - Y.*Z)*S2*(S_v))/Z^2 + (8*\exp(-Z - Y.*Z)*S2*(S_v))/Z^2 + (8*S2^2*(S_v))/\exp(3*Z)*Z^2); ... \\
- (4*S2^2*(S_v))/\exp(2*Z)*Z^2) + (S2^2*(S_v))/\exp(2*Z)*Z^2) - (S2^2*(S_v))./(\exp(3.*Y.*Z)*Z^2) - (S2^2*(S_v))./(\exp(Y.*Z)*Z^2) - (S2^2*(S_v))./(\exp(Y.*Z)*Z^2) - (\exp(-Z - 2.*Y.*Z)*S2^2*(S_v))/Z^2 ... \\
- (4*S2^2*(S_v))./(\exp(Y.*Z)*Z^2) - (\exp(-Z - 2.*Y.*Z)*S2^2*(S_v))/Z^2 ...
\end{aligned}$$

$$\begin{aligned}
& - \frac{(6*\exp(-2*Z) - Y.*Z)*S2^2*(S_v)/Z^2}{(6*S2.*Y.(S_v)/(exp(3*Z)*Z^2) + (8*S2.*Y.(S_v)/(exp(2*Z)*Z^2) ...)} \\
& - \frac{(2*S2.*Y.(S_v)/(exp(Z)*Z^2) + (2*S2.*Y.(S_v)/(exp(Y.*Z)*Z^2) + (6*\exp(-2*Z) - Y.*Z)*S2.*Y.(S_v)/Z^2 - (8*\exp(-Z - Y.*Z)*S2.*Y.(S_v)/Z^2 ...)} \\
& - \frac{(3*S2^2.*Y.(S_v)/(exp(3*Z)*Z^2) + (4*S2^2.*Y.(S_v)/(exp(2*Z)*Z^2) - (S2^2.*Y.(S_v)/(exp(Z)*Z^2) + (S2^2.*Y.(S_v)/(exp(Y.*Z)*Z^2) ...)} \\
& + (3*\exp(-2*Z - Y.*Z)*S2^2.*Y.(S_v)/Z^2 - (4*\exp(-Z - Y.*Z)*S2^2.*Y.(S_v)/Z^2 + (S2*(S_v)/Z + (2*S2*(S_v)/(exp(3*Z)*Z) + (9*S2*(S_v)/(exp(2*Z)*Z) ...)} \\
& - \frac{(4*S2*(S_v)/(exp(Z)*Z) + (S2*(S_v))/(exp(2.*Y.*Z)*Z) - (2*\exp(-2*Z - Y.*Z)*S2*(S_v)/Z + (\exp(-Z - Y.*Z)*S2*(S_v)/Z) / (2*S2*(S_v)/(exp(3*Z)*Z) ...)} \\
& + (S2^2*(S_v)/(exp(2*Z)*Z) - (2*\exp(-2*Z - Y.*Z)*S2^2*(S_v)/Z - (\exp(-Z - Y.*Z)*S2^2*(S_v)/Z - (2*S2.*Y.(S_v)/Z - (13*S2.*Y.(S_v)/(exp(2*Z)*Z) ...)} \\
& + (8*S2.*Y.(S_v)/(exp(Z)*Z) - (S2.*Y.(S_v))/(exp(2.*Y.*Z)*Z) - (2*S2^2.*Y.(S_v)/(exp(2*Z)*Z) + (2*\exp(-Z - Y.*Z)*S2^2.*Y.(S_v)/Z + (S2.*Y.^2*(S_v)/Z ...)} \\
& + (3*S2.*Y.^2*(S_v)/(exp(4*Z)*Z) - (4*S2.*Y.^2*(S_v)/(exp(3*Z)*Z) + (4*S2.*Y.^2*(S_v)/(exp(2*Z)*Z) - (4*S2.*Y.^2*(S_v)/(exp(3*Z)*Z) ...)} \\
& - (3*\exp(-3*Z - Y.*Z)*S2.*Y.^2*(S_v)/Z + (4*\exp(-2*Z - Y.*Z)*S2.*Y.^2*(S_v)/Z - (\exp(-Z - Y.*Z)*S2.*Y.^2*(S_v)/Z + (3*S2^2.*Y.^2*(S_v)/(exp(4*Z)*Z) ...)} \\
& - (4*S2^2.*Y.^2*(S_v)/(exp(3*Z)*Z) + (S2^2.*Y.^2*(S_v)/(exp(2*Z)*Z) - (3*\exp(-3*Z - Y.*Z)*S2^2.*Y.^2*(S_v)/Z + (4*\exp(-2*Z - Y.*Z)*S2^2.*Y.^2*(S_v)/Z ...)} \\
& - (\exp(-Z - Y.*Z)*S2^2.*Y.^2*(S_v)/Z - (3*S2^2*(S_v)/(4*\exp(4*Z)) - (7*S2^2*(S_v)/(4*\exp(2*Z)) - (3*S2^2*Z*(S_v)/(4*\exp(4*Z)) - (3*S2^2*Z*(S_v)/(4*\exp(2*Z)) ...)} \\
& + (2*S2.*Y.*Z*(S_v)/(exp(2*Z) + (S2^2.*Y.*Z*(S_v)/(exp(2*Z) + (S2.*Y.^2*Z*(S_v)/(exp(3*Z) + (3*S2.*Y.^2*Z*(S_v)/(2*\exp(2*Z)) + (S2^2.*Y.^2*Z*(S_v)/(exp(3*Z) ...)} \\
& + (S2^2.*Y.^2*Z*(S_v)/(2*\exp(2*Z)) - (2*S2.*Y.^3*Z*(S_v)/(exp(2*Z) - (S2^2.*Y.^4*Z*(S_v)/(4*\exp(4*Z)) - (S2.*Y.^4*Z*(S_v)/(exp(3*Z) ...)} \\
& + (S2^2.*Y.^4*Z*(S_v)/(exp(2*Z) + (3*S2.*Y.^4*Z*(S_v)/(4*\exp(4*Z)) - (S2.*Y.^4*Z*(S_v)/(exp(3*Z) ...)} \\
& ... \\
& + (S2.*Y.^4*Z*(S_v)/(4*\exp(2*Z)) + (3*S2^2.*Y.^4*Z*(S_v)/(4*\exp(4*Z)) - (S2^2.*Y.^4*Z*(S_v)/(exp(3*Z) + (S2^2.*Y.^4*Z*(S_v)/(4*\exp(2*Z)) + (S2^2.*Y.^4*Z*(S_v)/(2*\exp(3*Z)) ...)} \\
& + (S2^2.*Y.^2*Z^2*(S_v)/(2*\exp(3*Z)) - (S2.*Y.^2*Z^2*(S_v)/(exp(3*Z) - (S2^2.*Y.^2*Z^2*(S_v)/(exp(3*Z) + (S2.*Y.^4*Z^2*(S_v)/(2*\exp(3*Z)) ...)} \\
& + (S2^2.*Y.^4*Z^2*(S_v)/(2*\exp(3*Z)) + (9*S2^2*(S_v)^2)/(16*\exp(6*Z)) - (23*S2^2*(S_v)^2)/(8*\exp(4*Z)) + (2*S2^2*(S_v)^2)/(exp(3*Z) + (S2^2*(S_v)^2)/(16*\exp(2*Z)) ...)} \\
& - (\exp(-2*Z - 2.*Y.*Z)*S2^2*(S_v)^2/2 - \exp(-3*Z - Y.*Z)*S2^2*(S_v)^2 - (2*S2^2.*Y.(S_v)^2)/(exp(3*Z) - (S2^2.*Y.(S_v)^2)/(exp(2*Z) + (9*S2^2.*Y.^2*(S_v)^2)/(8*\exp(6*Z)) ...)} \\
& ... \\
& - (3*S2^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z)) + (11*S2^2.*Y.^2*(S_v)^2)/(2*\exp(4*Z)) - (7*S2^2.*Y.^2*(S_v)^2)/(2*\exp(3*Z)) + (15*S2^2.*Y.^2*(S_v)^2)/(8*\exp(2*Z)) ...)} \\
& + (\exp(-2*Z - 2.*Y.*Z)*S2^2.*Y.^2*(S_v)^2/2 + \exp(-3*Z - Y.*Z)*S2^2.*Y.^2*(S_v)^2 - (3*S2^2.*Y.^3*(S_v)^2)/(exp(4*Z) + (4*S2^2.*Y.^3*(S_v)^2)/(exp(3*Z) ...)} \\
& - (S2^2.*Y.^3*(S_v)^2)/(exp(2*Z) + (9*S2^2.*Y.^4*(S_v)^2)/(16*\exp(6*Z)) - (3*S2^2.*Y.^4*(S_v)^2)/(2*\exp(5*Z)) + (11*S2^2.*Y.^4*(S_v)^2)/(8*\exp(4*Z)) ...)} \\
& - (S2^2.*Y.^4*(S_v)^2)/(2*\exp(3*Z)) + (S2^2.*Y.^4*(S_v)^2)/(16*\exp(2*Z)) - (9*S2^2*(S_v)^2)/(4*\exp(6*Z)*Z^4) - (6*S2^2*(S_v)^2)/(exp(5*Z)*Z^4) ...)} \\
& + (11*S2^2*(S_v)^2)/(2*\exp(4*Z)*Z^4) - (2*S2^2*(S_v)^2)/(exp(3*Z)*Z^4) + (S2^2*(S_v)^2)/(4*\exp(2*Z)*Z^4) + (S2^2*(S_v)^2)/(2*\exp(2*Z)*Z^4) ...)} \\
& + (9*\exp(-4*Z - 2.*Y.*Z)*S2^2*(S_v)^2)/(4*Z^4) - (6*\exp(-3*Z - 2.*Y.*Z)*S2^2*(S_v)^2)/Z^4 + (11*\exp(-2*Z - 2.*Y.*Z)*S2^2*(S_v)^2)/(2*Z^4) ...)} \\
& - (2*\exp(-Z - 2.*Y.*Z)*S2^2*(S_v)^2)/Z^4 - (9*\exp(-5*Z - Y.*Z)*S2^2*(S_v)^2)/(2*Z^4) + (12*\exp(-4*Z - Y.*Z)*S2^2*(S_v)^2)/Z^4 - (11*\exp(-3*Z - Y.*Z)*S2^2*(S_v)^2)/Z^4 ...)} \\
& + (4*\exp(-2*Z - Y.*Z)*S2^2*(S_v)^2)/Z^4 - (\exp(-Z - Y.*Z)*S2^2*(S_v)^2)/(2*Z^4) + (12*S2^2*(S_v)^2)/(exp(5*Z)*Z^3) - (22*S2^2*(S_v)^2)/(exp(4*Z)*Z^3) ...)} \\
& + (27*S2^2*(S_v)^2)/(2*\exp(3*Z)*Z^3) - (4*S2^2*(S_v)^2)/(exp(2*Z)*Z^3) + (S2^2*(S_v)^2)/(2*\exp(3.*Y.*Z)*Z^3) ...)} \\
\end{aligned}$$

$$\begin{aligned}
& - (S2^2*(S_v)^2)/(2*\exp(Y.*Z)*Z^3) - (3*\exp(-2*Z - 3.*Y.*Z)*S2^2*(S_v)^2)/(2*Z^3) + (2*\exp(-Z - 3.*Y.*Z)*S2^2*(S_v)^2)/Z^3 - (3*\exp(-3*Z - 2.*Y.*Z)*S2^2*(S_v)^2)/(2*Z^3) \dots \\
& + (2*\exp(-2*Z - 2.*Y.*Z)*S2^2*(S_v)^2)/Z^3 - (\exp(-Z - 2.*Y.*Z)*S2^2*(S_v)^2)/(2*Z^3) - (9*\exp(-4*Z - Y.*Z)*S2^2*(S_v)^2)/Z^3 + (18*\exp(-3*Z - Y.*Z)*S2^2*(S_v)^2)/Z^3 \dots \\
& - (25*\exp(-2*Z - Y.*Z)*S2^2*(S_v)^2)/(2*Z^3) + (4*\exp(-Z - Y.*Z)*S2^2*(S_v)^2)/Z^3 - (9*S2^2.*Y.(S_v)^2)/(2*\exp(5*Z)*Z^3) + (12*S2^2.*Y.(S_v)^2)/(exp(4*Z)*Z^3) \dots \\
& - (11*S2^2.*Y.(S_v)^2)/(exp(3*Z)*Z^3) + (4*S2^2.*Y.(S_v)^2)/(exp(2*Z)*Z^3) - (S2^2.*Y.(S_v)^2)/(2*\exp(Z)*Z^3) + (S2^2.*Y.(S_v)^2)/(2*\exp(Y.*Z)*Z^3) \dots \\
& + (9*\exp(-4*Z - Y.*Z)*S2^2.*Y.(S_v)^2)/(2*Z^3) - (12*\exp(-3*Z - Y.*Z)*S2^2.*Y.(S_v)^2)/Z^3 + (11*\exp(-2*Z - Y.*Z)*S2^2.*Y.(S_v)^2)/Z^3 \dots \\
& - (4*\exp(-Z - Y.*Z)*S2^2.*Y.(S_v)^2)/Z^3 + (S2^2*(S_v)^2)/(4*Z^2) + (9*S2^2*(S_v)^2)/(4*\exp(6*Z)*Z^2) - (3*S2^2*(S_v)^2)/(exp(5*Z)*Z^2) + (19*S2^2*(S_v)^2)/(exp(4*Z)*Z^2) \dots \\
& - (19*S2^2*(S_v)^2)/(exp(3*Z)*Z^2) + (35*S2^2*(S_v)^2)/(4*\exp(2*Z)*Z^2) - (2*S2^2*(S_v)^2)/(exp(Z)*Z^2) + (S2^2*(S_v)^2)/(4*exp(4.*Y.*Z)*Z^2) \dots \\
& + (S2^2*(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2) + (\exp(-Z - 3.*Y.*Z)*S2^2*(S_v)^2)/Z^2 + (5*\exp(-2*Z - 2.*Y.*Z)*S2^2*(S_v)^2)/Z^2 - (2*\exp(-Z - 2.*Y.*Z)*S2^2*(S_v)^2)/Z^2 \dots \\
& - (9*\exp(-5*Z - Y.*Z)*S2^2*(S_v)^2)/(4*Z^2) + (3*\exp(-4*Z - Y.*Z)*S2^2*(S_v)^2)/Z^2 + (5*\exp(-3*Z - Y.*Z)*S2^2*(S_v)^2)/Z^2 - (\exp(-2*Z - Y.*Z)*S2^2*(S_v)^2)/Z^2 \dots \\
& + (\exp(-Z - Y.*Z)*S2^2*(S_v)^2)/(4*Z^2) - (S2^2.*Y.(S_v)^2)/(2*Z^2) - (15*S2^2.*Y.(S_v)^2)/(exp(4*Z)*Z^2) + (26*S2^2.*Y.(S_v)^2)/(exp(3*Z)*Z^2) \dots \\
& - (29*S2^2.*Y.(S_v)^2)/(2*\exp(2*Z)*Z^2) + (4*S2^2.*Y.(S_v)^2)/(exp(Z)*Z^2) - (S2^2.*Y.(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2) - (3*\exp(-2*Z - 2.*Y.*Z)*S2^2.*Y.(S_v)^2)/(2*Z^2) \dots \\
& + (2*\exp(-Z - 2.*Y.*Z)*S2^2.*Y.(S_v)^2)/Z^2 + (S2^2.*Y.^2*(S_v)^2)/(4*Z^2) - (9*S2^2.*Y.^2*(S_v)^2)/(4*\exp(6*Z)*Z^2) - (6*S2^2.*Y.^2*(S_v)^2)/(exp(5*Z)*Z^2) \dots \\
& + (31*S2^2.*Y.^2*(S_v)^2)/(4*\exp(4*Z)*Z^2) - (8*S2^2.*Y.^2*(S_v)^2)/(exp(3*Z)*Z^2) + (23*S2^2.*Y.^2*(S_v)^2)/(4*\exp(2*Z)*Z^2) - (2*S2^2.*Y.^2*(S_v)^2)/(exp(Z)*Z^2) \dots \\
& - (9*\exp(-5*Z - Y.*Z)*S2^2.*Y.^2*(S_v)^2)/(4*Z^2) + (6*\exp(-4*Z - Y.*Z)*S2^2.*Y.^2*(S_v)^2)/Z^2 - (11*\exp(-3*Z - Y.*Z)*S2^2.*Y.^2*(S_v)^2)/(2*Z^2) \dots \\
& + (2*\exp(-2*Z - Y.*Z)*S2^2.*Y.^2*(S_v)^2)/Z^2 - (\exp(-Z - Y.*Z)*S2^2.*Y.^2*(S_v)^2)/(4*Z^2) + (9*S2^2*(S_v)^2)/(2*\exp(5*Z)*Z) - (S2^2*(S_v)^2)/(exp(4*Z)*Z) \dots \\
& + (25*S2^2*(S_v)^2)/(4*\exp(3*Z)*Z) - (3*S2^2*(S_v)^2)/(exp(2*Z)*Z) + (3*S2^2*(S_v)^2)/(4*exp(Z)*Z) + (3*\exp(-3*Z - 2.*Y.*Z)*S2^2*(S_v)^2)/(4*Z) \dots \\
& + (3*\exp(-Z - 2.*Y.*Z)*S2^2*(S_v)^2)/(4*Z) + (3*\exp(-4*Z - Y.*Z)*S2^2*(S_v)^2)/Z - (2*\exp(-3*Z - Y.*Z)*S2^2*(S_v)^2)/Z + (2*\exp(-2*Z - Y.*Z)*S2^2*(S_v)^2)/Z \dots \\
& - (9*S2^2.*Y.(S_v)^2)/(4*\exp(5*Z)*Z) + (3*S2^2.*Y.(S_v)^2)/(exp(4*Z)*Z) - (11*S2^2.*Y.(S_v)^2)/(exp(3*Z)*Z) + (7*S2^2.*Y.(S_v)^2)/(exp(2*Z)*Z) \dots \\
& - (7*S2^2.*Y.(S_v)^2)/(4*\exp(Z)*Z) - (\exp(-Z - 2.*Y.*Z)*S2^2.*Y.(S_v)^2)/Z - (2*\exp(-2*Z - Y.*Z)*S2^2.*Y.(S_v)^2)/Z + (15*S2^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z)*Z) \dots \\
& - (13*S2^2.*Y.^2*(S_v)^2)/(exp(4*Z)*Z) + (41*S2^2.*Y.^2*(S_v)^2)/(4*\exp(3*Z)*Z) - (6*S2^2.*Y.^2*(S_v)^2)/(exp(2*Z)*Z) + (5*S2^2.*Y.^2*(S_v)^2)/(4*\exp(Z)*Z) \dots \\
& + (3*\exp(-3*Z - 2.*Y.*Z)*S2^2.*Y.^2*(S_v)^2)/(4*Z) - (\exp(-2*Z - 2.*Y.*Z)*S2^2.*Y.^2*(S_v)^2)/Z + (\exp(-Z - 2.*Y.*Z)*S2^2.*Y.^2*(S_v)^2)/(4*Z) \dots \\
& - (9*S2^2.*Y.^3*(S_v)^2)/(4*\exp(5*Z)*Z) + (6*S2^2.*Y.^3*(S_v)^2)/(exp(4*Z)*Z) - (11*S2^2.*Y.^3*(S_v)^2)/(2*\exp(3*Z)*Z) + (2*S2^2.*Y.^3*(S_v)^2)/(exp(2*Z)*Z) \dots \\
& - (S2^2.*Y.^3*(S_v)^2)/(4*\exp(Z)*Z) - (3*S2^2.*Z*(S_v)^2)/(4*\exp(3*Z)) + (S2^2.*Y.^Z*(S_v)^2)/(exp(3*Z)) - (S2^2.*Y.^2*Z*(S_v)^2)/(exp(4*Z)) \dots \\
& + (S2^2.*Y.^2*Z*(S_v)^2)/(2*\exp(3*Z)) - (S2^2.*Y.^3*Z*(S_v)^2)/(exp(4*Z)) + (3*S2^2.*Y.^4*Z*(S_v)^2)/(4*\exp(5*Z)) - (S2^2.*Y.^4*Z*(S_v)^2)/(exp(4*Z)) \dots \\
& + (S2^2.*Y.^4*Z*(S_v)^2)/(4*\exp(3*Z)) + (S2^2.*Y.^4*Z*(S_v)^2)/(exp(4*Z)) - (S2^2.*Y.^2*Z^2*(S_v)^2)/(4*\exp(4*Z)) - (S2^2.*Y.^2*Z^2*(S_v)^2)/(2*\exp(4*Z)) + (S2^2.*Y.^4*Z^2*(S_v)^2)/(4*\exp(4*Z));
\end{aligned}$$

Ns2=Nf+Nc+Ny2;  
 Phi2=Nf./[Nc+Ny2];  
 Be2=1./[1+Phi2];

```

Gf2=Nf./Ns2;
Gh2=[Nc+Ny2]./Ns2;
Nh2=Nc+Ny2;

```

```

S3=3;
Ny3=1 - exp(-2*Z) + exp(-Z - Y.*Z) - (2*S3)/exp(2*Z) + 2*exp(-Z - Y.*Z)*S3 - S3^2/exp(2*Z) + exp(-Z - Y.*Z)*S3^2 - 2.*Y + Y.^2 + Y.^2/exp(2*Z) - exp(-Z - Y.*Z).*Y.^2 ...
+ (2*S3.*Y.^2)/exp(2*Z) - 2*exp(-Z - Y.*Z)*S3.*Y.^2 + (S3^2.*Y.^2)/exp(2*Z) - exp(-Z - Y.*Z)*S3^2.*Y.^2 + 1/(exp(2*Z)*Z^2) + 1./(exp(2.*Y.*Z)*Z^2) ...
- (2*exp(-Z - Y.*Z))/Z^2 + (2*S3)/(exp(2*Z)*Z^2) + (2*S3)./(exp(2.*Y.*Z)*Z^2) - (4*exp(-Z - Y.*Z)*S3)/Z^2 + S3^2/(exp(2*Z)*Z^2) + S3^2./(exp(2.*Y.*Z)*Z^2) ...
- (2*exp(-Z - Y.*Z)*S3^2)/Z^2 + 2/(exp(Z)*Z) - 2./((exp(Y.*Z)*Z) + (2*S3)/(exp(Z)*Z) - (2*S3)./(exp(Y.*Z)*Z) - (2.*Y)/(exp(Z)*Z) + (2.*Y)/(exp(Y.*Z)*Z) ...
- (2*S3.*Y)/(exp(Z)*Z) + (2*S3.*Y)/(exp(Y.*Z)*Z) - Z/exp(Z) - (S3*Z)/exp(Z) + (Y.*Z)/exp(Z) + (S3.*Y.*Z)/exp(Z) + (Y.^2*Z)/exp(Z) + (S3.*Y.^2*Z)/exp(Z) - (Y.^3*Z)/exp(Z) ...
- (S3.*Y.^3*Z)/exp(Z) + Z^2/(4*exp(2*Z)) + (S3*Z^2)/(2*exp(2*Z)) + (S3^2*Z^2)/(4*exp(2*Z)) - (Y.^2*Z^2)/(2*exp(2*Z)) - (S3.*Y.^2*Z^2)/exp(2*Z) ...
- (S3^2.*Y.^2*Z^2)/(2*exp(2*Z)) + (Y.^4*Z^2)/(4*exp(2*Z)) + (S3.*Y.^4*Z^2)/(2*exp(2*Z)) + (S3^2.*Y.^4*Z^2)/(4*exp(2*Z)) - (7*S3*(S_v))/(2*exp(3*Z)) ...
+ (2*S3*(S_v))/exp(2*Z) + (S3*(S_v))/exp(Z) - (exp(-Z - 2.*Y.*Z)*S3*(S_v))/2 - (5*S3^2*(S_v))/exp(3*Z) + (2*S3^2*(S_v))/exp(2*Z) - (S3^2*(S_v))/(2*exp(Z)) ...
- (exp(-Z - 2.*Y.*Z)*S3^2*(S_v))/2 - (2*S3.*Y.*S3*(S_v))/exp(2*Z) - (3*S3.*Y.*S3*(S_v))/exp(Z) + (3*S3^2.*Y.*S3*(S_v))/(2*exp(3*Z)) - (2*S3^2.*Y.*S3*(S_v))/exp(2*Z) ...
+ (S3^2.*Y.*S3*(S_v))/(2*exp(Z)) + (13*S3.*Y.^2*(S_v))/(2*exp(3*Z)) - (4*S3.*Y.^2*(S_v))/exp(2*Z) + (3*S3.*Y.^2*(S_v))/exp(Z) + (exp(-Z - 2.*Y.*Z)*S3.*Y.^2*(S_v))/2 ...
+ (5*S3^2.*Y.^2*(S_v))/exp(3*Z) - (2*S3^2.*Y.^2*(S_v))/exp(2*Z) + (S3^2.*Y.^2*(S_v))/(2*exp(Z)) ...
+ (exp(-Z - 2.*Y.*Z)*S3^2*(S_v))/2 - (3*S3.*Y.^3*(S_v))/exp(3*Z) ...
+ (4*S3.*Y.^3*(S_v))/exp(2*Z) - (S3.*Y.^3*(S_v))/exp(Z) - (3*S3^2.*Y.^3*(S_v))/(2*exp(3*Z)) + (2*S3^2.*Y.^3*(S_v))/exp(2*Z) - (S3^2.*Y.^3*(S_v))/(2*exp(Z)) ...
+ (3*S3*(S_v))/(exp(4*Z)*Z^3) - (4*S3*(S_v))/(exp(3*Z)*Z^3) + (S3*(S_v))/(exp(2*Z)*Z^3) + (S3*(S_v))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S3*(S_v))/Z^3 ...
- (4*exp(-Z - 2.*Y.*Z)*S3*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S3*(S_v))/Z^3 + (8*exp(-2*Z - Y.*Z)*S3*(S_v))/Z^3 - (2*exp(-Z - Y.*Z)*S3*(S_v))/Z^3 ...
+ (3*S3^2*(S_v))/(exp(4*Z)*Z^3) - (4*S3^2*(S_v))/(exp(3*Z)*Z^3) + (S3^2*(S_v))/(exp(2*Z)*Z^3) + (S3^2*(S_v))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S3^2*(S_v))/Z^3 ...
- (4*exp(-Z - 2.*Y.*Z)*S3^2*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S3^2*(S_v))/Z^3 + (8*exp(-2*Z - Y.*Z)*S3^2*(S_v))/Z^3 - (2*exp(-Z - Y.*Z)*S3^2*(S_v))/Z^3 ...
+ (11*S3*(S_v))/(exp(3*Z)*Z^2) - (8*S3*(S_v))/(exp(2*Z)*Z^2) + (2*S3*(S_v))/(exp(Z)*Z^2) - (S3*(S_v))./(exp(3.*Y.*Z)*Z^2) - (2*S3*(S_v))./(exp(Y.*Z)*Z^2) ...
- (exp(-Z - 2.*Y.*Z)*S3*(S_v))/Z^2 - (9*exp(-2*Z - Y.*Z)*S3*(S_v))/Z^2 + (8*exp(-Z - Y.*Z)*S3*(S_v))/Z^2 + (8*S3^2*(S_v))/(exp(3*Z)*Z^2); ...
- (4*S3^2*(S_v))/(exp(2*Z)*Z^2) + (S3^2*(S_v))/(exp(Z)*Z^2) - (S3^2*(S_v))./(exp(3.*Y.*Z)*Z^2) - (S3^2*(S_v))./(exp(Y.*Z)*Z^2) - (exp(-Z - 2.*Y.*Z)*S3^2*(S_v))/Z^2 ...
- (6*exp(-2*Z - Y.*Z)*S3^2*(S_v))/Z^2 + (4*exp(-Z - Y.*Z)*S3^2*(S_v))/Z^2 - (6*S3.*Y.*S3*(S_v))/(exp(3*Z)*Z^2) + (8*S3.*Y.*S3*(S_v))/(exp(2*Z)*Z^2) ...
- (2*S3.*Y.*S3*(S_v))/(exp(Z)*Z^2) + (2*S3.*Y.*S3*(S_v))/(exp(Y.*Z)*Z^2) + (6*exp(-2*Z - Y.*Z)*S3.*Y.*S3*(S_v))/Z^2 - (8*exp(-Z - Y.*Z)*S3.*Y.*S3*(S_v))/Z^2 ...
- (3*S3^2.*Y.*S3*(S_v))/(exp(3*Z)*Z^2) + (4*S3^2.*Y.*S3*(S_v))/(exp(2*Z)*Z^2) - (S3^2.*Y.*S3*(S_v))/(exp(Z)*Z^2) + (S3^2.*Y.*S3*(S_v))/(exp(Y.*Z)*Z^2) ...
+ (3*exp(-2*Z - Y.*Z)*S3^2.*Y.*S3*(S_v))/Z^2 - (4*exp(-Z - Y.*Z)*S3^2.*Y.*S3*(S_v))/Z^2 + (S3*(S_v))/Z + (2*S3*(S_v))/(exp(3*Z)*Z) + (9*S3*(S_v))/(exp(2*Z)*Z) ...
- (4*S3*(S_v))/(exp(Z)*Z) + (S3*(S_v))./(exp(2.*Y.*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S3*(S_v))/Z + (exp(-Z - Y.*Z)*S3*(S_v))/Z + (2*S3^2*(S_v))/(exp(3*Z)*Z) ...
+ (S3^2*(S_v))/(exp(2*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S3^2*(S_v))/Z - (exp(-Z - Y.*Z)*S3^2*(S_v))/Z - (2*S3.*Y.*S3*(S_v))/Z - (13*S3.*Y.*S3*(S_v))/(exp(2*Z)*Z) ...

```

$$\begin{aligned}
& + \frac{(8*S3.*Y.*(S_v))/(exp(Z)*Z)}{(2*S3^2.*Y.*(S_v))/(exp(2*Z)*Z) + (2*exp(-Z - Y.*Z)*S3^2.*Y.*(S_v))/Z + (S3.*Y.^2*(S_v))/Z} \\
& + \frac{(3*S3.*Y.^2*(S_v))/(exp(4*Z)*Z)}{(4*S3.*Y.^2*(S_v))/(exp(2*Z)*Z) - (4*S3.*Y.^2*(S_v))/(exp(Z)*Z) ...} \\
& - (3*exp(-3*Z - Y.*Z)*S3.*Y.^2*(S_v))/Z + (4*exp(-2*Z - Y.*Z)*S3.*Y.^2*(S_v))/Z - (exp(-Z - Y.*Z)*S3.*Y.^2*(S_v))/Z + (3*S3^2.*Y.^2*(S_v))/(exp(4*Z)*Z) ... \\
& - (4*S3^2.*Y.^2*(S_v))/(exp(3*Z)*Z) + (S3^2.*Y.^2*(S_v))/(exp(2*Z)*Z) - (3*exp(-3*Z - Y.*Z)*S3^2.*Y.^2*(S_v))/Z + (4*exp(-2*Z - Y.*Z)*S3^2.*Y.^2*(S_v))/Z ... \\
& - (4*S3^2.*Y.^2*(S_v))/(exp(3*Z)*Z) + (S3^2.*Y.^2*(S_v))/(exp(2*Z)*Z) - (3*exp(-3*Z - Y.*Z)*S3^2.*Y.^2*(S_v))/Z + (4*exp(-2*Z - Y.*Z)*S3^2.*Y.^2*(S_v))/Z ... \\
& - (exp(-Z - Y.*Z)*S3^2.*Y.^2*(S_v))/Z - (3*S3^2.*Y.^2*(S_v))/(4*exp(4*Z)) - (7*S3^2.*Y.^2*(S_v))/(4*exp(2*Z)) \\
& - (3*S3^2.*Y.^2*(S_v))/(4*exp(4*Z)) - (3*S3^2.*Y.^2*(S_v))/(4*exp(2*Z)) ... \\
& + (2*S3.*Y.^2*(S_v))/(exp(2*Z) + (S3^2.*Y.^2*(S_v))/(exp(2*Z) + (S3.*Y.^2*(S_v))/exp(3*Z) + (3*S3.*Y.^2*(S_v))/(2*exp(2*Z)) + (S3^2.*Y.^2*(S_v))/(exp(3*Z) ... \\
& + (S3^2.*Y.^2*(S_v))/(2*exp(2*Z)) - (2*S3.*Y.^3*(S_v))/(exp(2*Z)) - (S3^2.*Y.^3*(S_v))/(exp(3*Z) ... \\
& (S3^2.*Y.^3*(S_v))/(exp(2*Z) + (3*S3.*Y.^4*(S_v))/(4*exp(4*Z)) - (S3.*Y.^4*(S_v))/(exp(3*Z) ... \\
& ... \\
& + (S3.*Y.^4*(S_v))/(4*exp(2*Z)) + (3*S3^2.*Y.^4*(S_v))/(4*exp(4*Z)) - (S3^2.*Y.^4*(S_v))/(exp(3*Z) ... \\
& (S3^2.*Y.^4*(S_v))/(exp(3*Z) + (S3^2.*Y.^4*(S_v))/(4*exp(2*Z)) + (S3^2.*Y.^4*(S_v))/(2*exp(3*Z) ... \\
& ... \\
& + (S3^2.*Y.^2*(S_v))/(2*exp(3*Z)) - (S3.*Y.^2*(S_v))/(exp(3*Z) ... \\
& (S3^2.*Y.^2*(S_v))/(exp(3*Z) + (S3.*Y.^4*(S_v))/(2*exp(3*Z)) ... \\
& + (S3^2.*Y.^4*(S_v))/(2*exp(3*Z)) + (9*S3^2*(S_v)^2)/(16*exp(6*Z)) ... \\
& (23*S3^2*(S_v)^2)/(8*exp(4*Z)) + (2*S3^2*(S_v)^2)/(exp(3*Z) + (S3^2*(S_v)^2)/(16*exp(2*Z)) ... \\
& - (exp(-2*Z - 2.*Y.*Z)*S3^2*(S_v)^2)/2 - exp(-3*Z - Y.*Z)*S3^2*(S_v)^2 - \\
& (2*S3^2.*Y.^(S_v)^2)/(exp(3*Z) - (S3^2.*Y.^(S_v)^2)/(exp(2*Z) + (9*S3^2.*Y.^2*(S_v)^2)/(8*exp(6*Z)) ... \\
& ... \\
& - (3*S3^2.*Y.^2*(S_v)^2)/(2*exp(5*Z)) + (11*S3^2.*Y.^2*(S_v)^2)/(2*exp(4*Z)) - \\
& (7*S3^2.*Y.^2*(S_v)^2)/(2*exp(3*Z)) + (15*S3^2.*Y.^2*(S_v)^2)/(8*exp(2*Z)) ... \\
& + (exp(-2*Z - 2.*Y.*Z)*S3^2.*Y.^2*(S_v)^2)/2 + exp(-3*Z - Y.*Z)*S3^2.*Y.^2*(S_v)^2 - \\
& (3*S3^2.*Y.^3*(S_v)^2)/(exp(4*Z) + (4*S3^2.*Y.^3*(S_v)^2)/(exp(3*Z) ... \\
& - (S3^2.*Y.^3*(S_v)^2)/(exp(2*Z)) + (9*S3^2.*Y.^4*(S_v)^2)/(16*exp(6*Z)) - \\
& (3*S3^2.*Y.^4*(S_v)^2)/(2*exp(5*Z)) + (11*S3^2.*Y.^4*(S_v)^2)/(8*exp(4*Z)) ... \\
& - (S3^2.*Y.^4*(S_v)^2)/(2*exp(3*Z)) + (S3^2.*Y.^4*(S_v)^2)/(16*exp(2*Z)) + \\
& (9*S3^2*(S_v)^2)/(4*exp(6*Z)*Z^4) - (6*S3^2*(S_v)^2)/(exp(5*Z)*Z^4) ... \\
& + (11*S3^2*(S_v)^2)/(2*exp(4*Z)*Z^4) - (2*S3^2*(S_v)^2)/(exp(3*Z)*Z^4) + \\
& (S3^2*(S_v)^2)/(4*exp(2*Z)*Z^4) + (S3^2*(S_v)^2)/(4*exp(2*Z)*Z^4) ... \\
& + (9*exp(-4*Z - 2.*Y.*Z)*S3^2*(S_v)^2)/(4*Z^4) - (6*exp(-3*Z - 2.*Y.*Z)*S3^2*(S_v)^2)/Z^4 + \\
& (11*exp(-2*Z - 2.*Y.*Z)*S3^2*(S_v)^2)/(2*Z^4) ... \\
& - (2*exp(-Z - 2.*Y.*Z)*S3^2*(S_v)^2)/Z^4 - (9*exp(-5*Z - Y.*Z)*S3^2*(S_v)^2)/(2*Z^4) + (12*exp(- \\
& 4*Z - Y.*Z)*S3^2*(S_v)^2)/Z^4 - (11*exp(-3*Z - Y.*Z)*S3^2*(S_v)^2)/Z^4 ... \\
& + (4*exp(-2*Z - Y.*Z)*S3^2*(S_v)^2)/Z^4 - (exp(-Z - Y.*Z)*S3^2*(S_v)^2)/(2*Z^4) + \\
& (12*S3^2*(S_v)^2)/(exp(5*Z)*Z^3) - (22*S3^2*(S_v)^2)/(exp(4*Z)*Z^3) ... \\
& + (27*S3^2*(S_v)^2)/(2*exp(3*Z)*Z^3) - (4*S3^2*(S_v)^2)/(exp(2*Z)*Z^3) + \\
& (S3^2*(S_v)^2)/(2*exp(Z)*Z^3) - (S3^2*(S_v)^2)/(2*exp(3.*Y.*Z)*Z^3) ... \\
& - (S3^2*(S_v)^2)/(2*exp(Y.*Z)*Z^3) - (3*exp(-2*Z - 3.*Y.*Z)*S3^2*(S_v)^2)/(2*Z^3) + (2*exp(-Z - \\
& 3.*Y.*Z)*S3^2*(S_v)^2)/Z^3 - (3*exp(-3*Z - 2.*Y.*Z)*S3^2*(S_v)^2)/(2*Z^3) ... \\
& + (2*exp(-2*Z - 2.*Y.*Z)*S3^2*(S_v)^2)/Z^3 - (exp(-Z - 2.*Y.*Z)*S3^2*(S_v)^2)/(2*Z^3) - (9*exp(- \\
& 4*Z - Y.*Z)*S3^2*(S_v)^2)/Z^3 + (18*exp(-3*Z - Y.*Z)*S3^2*(S_v)^2)/Z^3 ... \\
& - (25*exp(-2*Z - Y.*Z)*S3^2*(S_v)^2)/(2*Z^3) + (4*exp(-Z - Y.*Z)*S3^2*(S_v)^2)/Z^3 - \\
& (9*S3^2.*Y.^(S_v)^2)/(2*exp(5*Z)*Z^3) + (12*S3^2.*Y.^(S_v)^2)/(exp(4*Z)*Z^3) ... \\
& - (11*S3^2.*Y.^(S_v)^2)/(exp(3*Z)*Z^3) + (4*S3^2.*Y.^(S_v)^2)/(exp(2*Z)*Z^3) - \\
& (S3^2.*Y.^(S_v)^2)/(2*exp(Z)*Z^3) + (S3^2.*Y.^(S_v)^2)/(2*exp(Y.*Z)*Z^3) ... \\
& + (9*exp(-4*Z - Y.*Z)*S3^2.*Y.^(S_v)^2)/(2*Z^3) - (12*exp(-3*Z - Y.*Z)*S3^2.*Y.^(S_v)^2)/Z^3 + \\
& (11*exp(-2*Z - Y.*Z)*S3^2.*Y.^(S_v)^2)/Z^3 ... \\
& - (4*exp(-Z - Y.*Z)*S3^2.*Y.^(S_v)^2)/Z^3 + (S3^2*(S_v)^2)/(4*Z^2) + \\
& (9*S3^2*(S_v)^2)/(4*exp(6*Z)*Z^2) - (3*S3^2*(S_v)^2)/(exp(5*Z)*Z^2) + \\
& (19*S3^2*(S_v)^2)/(exp(4*Z)*Z^2) ...
\end{aligned}$$

$$\begin{aligned}
& - \frac{(19*S3^2*(S_v)^2)/(exp(3*Z)*Z^2)}{(2*S3^2*(S_v)^2)/(exp(Z)*Z^2) + (S3^2*(S_v)^2)./(4*exp(4.*Y.*Z)*Z^2)} + \frac{(35*S3^2*(S_v)^2)/(4*exp(2*Z)*Z^2)}{(2*exp(-Z - 3.*Y.*Z)*S3^2*(S_v)^2)/Z^2 + (5*exp(-2*Z - 2.*Y.*Z)*S3^2*(S_v)^2)/Z^2} \\
& + \frac{(S3^2*(S_v)^2)./(2*exp(2.*Y.*Z)*Z^2) + (exp(-Z - 3.*Y.*Z)*S3^2*(S_v)^2)/Z^2}{(9*exp(-5*Z - Y.*Z)*S3^2*(S_v)^2)/(4*Z^2) + (3*exp(-4*Z - Y.*Z)*S3^2*(S_v)^2)/Z^2 + (5*exp(-3*Z - Y.*Z)*S3^2*(S_v)^2)/Z^2 - (exp(-2*Z - Y.*Z)*S3^2*(S_v)^2)/Z^2} \\
& + \frac{(exp(-Z - 2.*Y.*Z)*S3^2*(S_v)^2)/(4*Z^2)}{(15*S3^2.*Y.(S_v)^2)/(exp(4*Z)*Z^2) + (26*S3^2.*Y.(S_v)^2)/(exp(3*Z)*Z^2)} \\
& - \frac{(29*S3^2.*Y.(S_v)^2)/(2*exp(2*Z)*Z^2)}{(S3^2.*Y.(S_v)^2)/(2*exp(2.*Y.*Z)*Z^2) - (3*exp(-2*Z - 2.*Y.*Z)*S3^2.*Y.(S_v)^2)/(2*Z^2)} \\
& + \frac{(2*exp(-Z - 2.*Y.*Z)*S3^2.*Y.(S_v)^2)/Z^2}{(9*S3^2.*Y.^2*(S_v)^2)/(4*exp(6*Z)*Z^2) - (6*S3^2.*Y.^2*(S_v)^2)/(exp(5*Z)*Z^2)} \\
& + \frac{(31*S3^2.*Y.^2*(S_v)^2)/(4*exp(4*Z)*Z^2)}{(23*S3^2.*Y.^2*(S_v)^2)/(4*exp(2*Z)*Z^2) - (2*S3^2.*Y.^2*(S_v)^2)/(exp(Z)*Z^2)} \\
& - \frac{(9*exp(-5*Z - Y.*Z)*S3^2.*Y.^2*(S_v)^2)/(4*Z^2) + (6*exp(-4*Z - Y.*Z)*S3^2.*Y.^2*(S_v)^2)/Z^2}{(11*exp(-3*Z - Y.*Z)*S3^2.*Y.^2*(S_v)^2)/(2*Z^2)} \\
& + \frac{(2*exp(-2*Z - Y.*Z)*S3^2.*Y.^2*(S_v)^2)/Z^2 - (exp(-Z - Y.*Z)*S3^2.*Y.^2*(S_v)^2)/(4*Z^2) + (9*S3^2*(S_v)^2)/(2*exp(5*Z)*Z) - (S3^2*(S_v)^2)/(exp(4*Z)*Z)} \\
& + \frac{(25*S3^2*(S_v)^2)/(4*exp(3*Z)*Z)}{(3*S3^2*(S_v)^2)/(4*exp(Z)*Z) + (3*exp(-3*Z - 2.*Y.*Z)*S3^2*(S_v)^2)/(4*Z)} \\
& + \frac{(3*exp(-Z - 2.*Y.*Z)*S3^2*(S_v)^2)/(4*Z) + (3*exp(-4*Z - Y.*Z)*S3^2*(S_v)^2)/Z - (2*exp(-3*Z - Y.*Z)*S3^2*(S_v)^2)/Z + (2*exp(-2*Z - Y.*Z)*S3^2*(S_v)^2)/Z} \\
& - \frac{(9*S3^2.*Y.(S_v)^2)/(4*exp(5*Z)*Z)}{(11*S3^2.*Y.(S_v)^2)/(exp(3*Z)*Z) + (7*S3^2.*Y.(S_v)^2)/(exp(2*Z)*Z)} \\
& - \frac{(7*S3^2.*Y.(S_v)^2)/(4*exp(Z)*Z) - (exp(-Z - 2.*Y.*Z)*S3^2.*Y.(S_v)^2)/Z - (2*exp(-2*Z - Y.*Z)*S3^2.*Y.(S_v)^2)/Z + (15*S3^2.*Y.^2*(S_v)^2)/(2*exp(5*Z)*Z)} \\
& - \frac{(13*S3^2.*Y.^2*(S_v)^2)/(exp(4*Z)*Z)}{(6*S3^2.*Y.^2*(S_v)^2)/(exp(2*Z)*Z) + (5*S3^2.*Y.^2*(S_v)^2)/(4*exp(Z)*Z)} \\
& + \frac{(3*exp(-3*Z - 2.*Y.*Z)*S3^2.*Y.^2*(S_v)^2)/(4*Z) - (exp(-2*Z - 2.*Y.*Z)*S3^2.*Y.^2*(S_v)^2)/Z + (exp(-Z - 2.*Y.*Z)*S3^2.*Y.^2*(S_v)^2)/(4*Z)} \\
& - \frac{(9*S3^2.*Y.^3*(S_v)^2)/(4*exp(5*Z)*Z)}{(11*S3^2.*Y.^3*(S_v)^2)/(2*exp(3*Z)*Z) + (2*S3^2.*Y.^3*(S_v)^2)/(exp(2*Z)*Z)} \\
& - \frac{(S3^2.*Y.^3*(S_v)^2)/(4*exp(Z)*Z)}{(3*S3^2*Z*(S_v)^2)/(4*exp(3*Z))} + \frac{(S3^2.*Y.^2*(S_v)^2)/(exp(3*Z))}{(S3^2.*Y.^2*Z*(S_v)^2)/exp(4*Z)} \\
& + \frac{(S3^2.*Y.^2*Z*(S_v)^2)/(2*exp(3*Z))}{(3*S3^2.*Y.^4*Z*(S_v)^2)/(4*exp(5*Z)) - (S3^2.*Y.^4*Z*(S_v)^2)/exp(4*Z)} \\
& + \frac{(S3^2.*Y.^4*Z*(S_v)^2)/(4*exp(3*Z))}{(S3^2.*Y.^2*Z^2*(S_v)^2)/(4*exp(4*Z))} \\
& (S3^2.*Y.^2*Z^2*(S_v)^2)/(2*exp(4*Z)) + (S3^2.*Y.^4*Z^2*(S_v)^2)/(4*exp(4*Z));
\end{aligned}$$

Ns3=Nf+Nc+Ny3;  
 Phi3=Nf./[Nc+Ny3];  
 Be3=1./[1+Phi3];  
 Gf3=Nf./Ns3;  
 Gh3=[Nc+Ny3]./Ns3;  
 Nh3=Nc+Ny3;

$$\begin{aligned}
& S4=4; \\
& Ny4=1 - exp(-2*Z) + exp(-Z - Y.*Z) - (2*S4)/exp(2*Z) + 2*exp(-Z - Y.*Z)*S4 - S4^2/exp(2*Z) + exp(-Z - Y.*Z)*S4^2 - 2.*Y + Y.^2 + Y.^2/exp(2*Z) - exp(-Z - Y.*Z).*Y.^2 \\
& + (2*S4.*Y.^2)/exp(2*Z) - 2*exp(-Z - Y.*Z)*S4.*Y.^2 + (S4^2.*Y.^2)/exp(2*Z) - exp(-Z - Y.*Z)*S4^2.*Y.^2 + 1/(exp(2*Z)*Z^2) + 1./(exp(2.*Y.*Z)*Z^2) ... \\
& - (2*exp(-Z - Y.*Z))/Z^2 + (2*S4)/(exp(2*Z)*Z^2) + (2*S4)./(exp(2.*Y.*Z)*Z^2) - (4*exp(-Z - Y.*Z)*S4)/Z^2 + S4^2/(exp(2*Z)*Z^2) + S4^2./(exp(2.*Y.*Z)*Z^2) ...
\end{aligned}$$

$$\begin{aligned}
& - \frac{(2*\exp(-Z - Y.*Z)*S4^2)/Z^2 + 2/(\exp(Z)*Z) - 2./(\exp(Y.*Z)*Z) + (2*S4)/(\exp(Z)*Z)}{(2*S4)./(\exp(Y.*Z)*Z) - (2.*Y)/(\exp(Z)*Z) + (2.*Y)/(\exp(Y.*Z)*Z)} \\
& - \frac{(2*S4.*Y)/(\exp(Z)*Z) + (2*S4.*Y)/(\exp(Y.*Z)*Z) - Z/\exp(Z) - (S4*Z)/\exp(Z) + (Y.*Z)/\exp(Z) + (S4.*Y.*Z)/\exp(Z) + (Y.^2*Z)/\exp(Z) + (S4.*Y.^2*Z)/\exp(Z) - (Y.^3*Z)/\exp(Z)}{(S4.*Y.^3*Z)/\exp(Z) + Z^2/(4*\exp(2*Z)) + (S4*Z^2)/(2*\exp(2*Z)) + (S4^2*Z^2)/(4*\exp(2*Z)) - (Y.^2*Z^2)/(2*\exp(2*Z)) - (S4.*Y.^2*Z^2)/\exp(2*Z)} \\
& - \frac{(S4.^2.*Y.^2*Z^2)/(2*\exp(2*Z)) + (Y.^4*Z^2)/(4*\exp(2*Z)) + (S4.*Y.^4*Z^2)/(2*\exp(2*Z)) + (S4^2.*Y.^4*Z^2)/(4*\exp(2*Z)) - (7*S4*(S_v))/(2*\exp(3*Z))}{(S4.^2.*Y.^4*Z^2)/(4*\exp(2*Z))} \\
& + \frac{(2*S4*(S_v))/\exp(2*Z) + (S4*(S_v))/\exp(Z) - (\exp(-Z - 2.*Y.*Z)*S4*(S_v))/2 - (5*S4^2*(S_v))/\exp(3*Z) + (2*S4^2*(S_v))/\exp(2*Z) - (S4^2*(S_v))/(2*\exp(Z))}{(5*S4^2*(S_v))/\exp(3*Z) + (2*S4^2*(S_v))/\exp(2*Z) - (S4^2*(S_v))/(2*\exp(Z))} \\
& - \frac{(\exp(-Z - 2.*Y.*Z)*S4^2*(S_v))/2 - (2*S4.*Y.*S4*(S_v))/\exp(2*Z) - (3*S4.*Y.*S4*(S_v))/\exp(Z) + (3*S4^2.*Y.*S4*(S_v))/(2*\exp(3*Z)) - (2*S4^2.*Y.*S4*(S_v))/\exp(2*Z)}{(S4.^2.*Y.^2*Z^2)/(2*\exp(2*Z))} \\
& + \frac{(S4.^2.*Y.^2*Z^2)/(2*\exp(2*Z)) + (Y.^4*Z^2)/(4*\exp(2*Z)) + (S4.*Y.^4*Z^2)/(2*\exp(2*Z)) + (S4^2.*Y.^4*Z^2)/(4*\exp(2*Z)) - (7*S4*(S_v))/(2*\exp(3*Z))}{(S4.^2.*Y.^4*Z^2)/(4*\exp(2*Z))} \\
& + \frac{(2*S4*(S_v))/\exp(2*Z) + (S4*(S_v))/\exp(Z) - (\exp(-Z - 2.*Y.*Z)*S4*(S_v))/2 - (5*S4^2*(S_v))/\exp(3*Z) + (2*S4^2*(S_v))/\exp(2*Z) - (S4^2*(S_v))/(2*\exp(Z))}{(5*S4^2*(S_v))/\exp(3*Z) + (2*S4^2*(S_v))/\exp(2*Z) - (S4^2*(S_v))/(2*\exp(Z))} \\
& - \frac{(\exp(-Z - 2.*Y.*Z)*S4^2*(S_v))/2 - (2*S4.*Y.^2*Z^2)/(2*\exp(3*Z)) - (4*S4.*Y.^2*Z^2)/(2*\exp(3*Z)) + (3*S4.*Y.^2*Z^2)/(2*\exp(3*Z)) + (S4.^2.*Y.^2*Z^2)/(2*\exp(3*Z)) - (2*S4.^2.*Y.^2*Z^2)/(2*\exp(3*Z))}{(S4.^2.*Y.^2*Z^2)/(2*\exp(3*Z))} \\
& + \frac{(5*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)) - (2*S4.^2.*Y.^2*Z^2)/(2*\exp(3*Z)) + (S4.^2.*Y.^2*Z^2)/(2*\exp(3*Z)) + (\exp(-Z - 2.*Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)) - (3*S4.^2.*Y.^3*Z^2)/(2*\exp(3*Z))}{(5*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z))} \\
& + \frac{(4*S4.*Y.^3*Z^2)/(2*\exp(3*Z)) - (S4.*Y.^3*Z^2)/(2*\exp(3*Z)) - (3*S4.^2.*Y.^3*Z^2)/(2*\exp(3*Z)) + (2*S4^2.*Y.^3*Z^2)/(2*\exp(3*Z)) - (S4^2.*Y.^3*Z^2)/(2*\exp(3*Z))}{(4*S4.*Y.^3*Z^2)/(2*\exp(3*Z))} \\
& + \frac{(3*S4*(S_v))/\exp(4*Z)*Z^3) - (4*S4*(S_v))/\exp(3*Z)*Z^3 + (S4*(S_v))/\exp(2*Z)*Z^3 + (S4*(S_v))/\exp(2*Z)*Z^3 + (3*exp(-2*Z - 2.*Y.*Z)*S4*(S_v))/Z^3 ...}{(3*S4*(S_v))/\exp(4*Z)*Z^3) - (4*S4*(S_v))/\exp(3*Z)*Z^3 + (S4*(S_v))/\exp(2*Z)*Z^3 + (S4*(S_v))/\exp(2*Z)*Z^3} \\
& - \frac{(4*exp(-Z - 2.*Y.*Z)*S4*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S4*(S_v))/Z^3 + (8*exp(-2*Z - Y.*Z)*S4*(S_v))/Z^3 - (2*exp(-Z - Y.*Z)*S4*(S_v))/Z^3}{(4*exp(-Z - 2.*Y.*Z)*S4*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S4*(S_v))/Z^3 + (8*exp(-2*Z - Y.*Z)*S4*(S_v))/Z^3} \\
& + \frac{(3*S4^2*(S_v))/\exp(4*Z)*Z^3) - (4*S4^2*(S_v))/\exp(3*Z)*Z^3 + (S4^2*(S_v))/\exp(2*Z)*Z^3 + (S4^2*(S_v))/\exp(2*Z)*Z^3 ...}{(3*S4^2*(S_v))/\exp(4*Z)*Z^3) - (4*S4^2*(S_v))/\exp(3*Z)*Z^3 + (S4^2*(S_v))/\exp(2*Z)*Z^3} \\
& - \frac{(4*exp(-Z - 2.*Y.*Z)*S4^2*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S4^2*(S_v))/Z^3 + (8*exp(-2*Z - Y.*Z)*S4^2*(S_v))/Z^3 - (2*exp(-Z - Y.*Z)*S4^2*(S_v))/Z^3}{(4*exp(-Z - 2.*Y.*Z)*S4^2*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S4^2*(S_v))/Z^3 + (8*exp(-2*Z - Y.*Z)*S4^2*(S_v))/Z^3} \\
& + \frac{(11*S4*(S_v))/\exp(3*Z)*Z^2) - (8*S4*(S_v))/\exp(2*Z)*Z^2 + (2*S4*(S_v))/\exp(2*Z)*Z^2 - (S4*(S_v))/\exp(3*Z)*Z^2 ...}{(11*S4*(S_v))/\exp(3*Z)*Z^2) - (8*S4*(S_v))/\exp(2*Z)*Z^2 + (2*S4*(S_v))/\exp(2*Z)*Z^2} \\
& - \frac{(\exp(-Z - 2.*Y.*Z)*S4*(S_v))/Z^2 - (9*exp(-2*Z - Y.*Z)*S4*(S_v))/Z^2 + (8*exp(-Z - Y.*Z)*S4*(S_v))/Z^2 + (8*S4^2*(S_v))/\exp(3*Z)*Z^2; ...}{(\exp(-Z - 2.*Y.*Z)*S4*(S_v))/Z^2 - (9*exp(-2*Z - Y.*Z)*S4*(S_v))/Z^2 + (8*exp(-Z - Y.*Z)*S4*(S_v))/Z^2 + (8*S4^2*(S_v))/\exp(3*Z)*Z^2; ...} \\
& - \frac{(4*S4^2*(S_v))/\exp(2*Z)*Z^2 + (S4^2*(S_v))/\exp(2*Z)*Z^2 - (S4^2*(S_v))/\exp(3*Y.*Z)*Z^2 - (S4^2*(S_v))/\exp(3*Y.*Z)*Z^2 ...}{(4*S4^2*(S_v))/\exp(2*Z)*Z^2 + (S4^2*(S_v))/\exp(2*Z)*Z^2 - (S4^2*(S_v))/\exp(3*Y.*Z)*Z^2 - (S4^2*(S_v))/\exp(3*Y.*Z)*Z^2} \\
& - \frac{(6*exp(-2*Z - Y.*Z)*S4^2*(S_v))/Z^2 + (4*exp(-Z - 2.*Y.*Z)*S4^2*(S_v))/Z^2 - (6*S4.*Y.*S4*(S_v))/\exp(3*Z)*Z^2 + (8*S4.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 ...}{(6*exp(-2*Z - Y.*Z)*S4^2*(S_v))/Z^2 + (4*exp(-Z - 2.*Y.*Z)*S4^2*(S_v))/Z^2 - (6*S4.*Y.*S4*(S_v))/\exp(3*Z)*Z^2 + (8*S4.*Y.*S4*(S_v))/\exp(2*Z)*Z^2} \\
& - \frac{(2*S4.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 + (2*S4.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 - (8*exp(-Z - Y.*Z)*S4.*Y.*S4*(S_v))/Z^2 ...}{(2*S4.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 + (2*S4.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 - (8*exp(-Z - Y.*Z)*S4.*Y.*S4*(S_v))/Z^2} \\
& - \frac{(3*S4^2.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 + (4*S4^2.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 - (S4^2.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 + (S4^2.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 ...}{(3*S4^2.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 + (4*S4^2.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 - (S4^2.*Y.*S4*(S_v))/\exp(2*Z)*Z^2 + (S4^2.*Y.*S4*(S_v))/\exp(2*Z)*Z^2} \\
& + \frac{(3*exp(-2*Z - Y.*Z)*S4^2.*Y.*S4*(S_v))/Z^2 - (4*exp(-Z - Y.*Z)*S4^2.*Y.*S4*(S_v))/Z^2 + (S4*(S_v))/\exp(2*Z)*Z ...}{(3*exp(-2*Z - Y.*Z)*S4^2.*Y.*S4*(S_v))/Z^2 - (4*exp(-Z - Y.*Z)*S4^2.*Y.*S4*(S_v))/Z^2 + (S4*(S_v))/\exp(2*Z)*Z} \\
& - \frac{(4*S4*(S_v))/\exp(2*Z)*Z + (S4*(S_v))/\exp(2*Z)*Z - (2*exp(-2*Z - Y.*Z)*S4*(S_v))/Z + (exp(-Z - Y.*Z)*S4*(S_v))/Z + (exp(-Z - Y.*Z)*S4*(S_v))/Z + (2*S4*(S_v))/\exp(2*Z)*Z ...}{(4*S4*(S_v))/\exp(2*Z)*Z + (S4*(S_v))/\exp(2*Z)*Z - (2*exp(-2*Z - Y.*Z)*S4*(S_v))/Z + (exp(-Z - Y.*Z)*S4*(S_v))/Z + (exp(-Z - Y.*Z)*S4*(S_v))/Z + (2*S4*(S_v))/\exp(2*Z)*Z} \\
& + \frac{(8*S4.*Y.*S4*(S_v))/\exp(2*Z) - (S4.*Y.*S4*(S_v))/\exp(2*Z) - (2*S4^2.*Y.*S4*(S_v))/\exp(2*Z) + (2*S4^2.*Y.*S4*(S_v))/\exp(2*Z) + (3*S4.*Y.^2*Z^2)/(2*\exp(4*Z)*Z) - (4*S4.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) ...}{(8*S4.*Y.*S4*(S_v))/\exp(2*Z) - (S4.*Y.*S4*(S_v))/\exp(2*Z) - (2*S4^2.*Y.*S4*(S_v))/\exp(2*Z) + (2*S4^2.*Y.*S4*(S_v))/\exp(2*Z) + (3*S4.*Y.^2*Z^2)/(2*\exp(4*Z)*Z) - (4*S4.*Y.^2*Z^2)/(2*\exp(3*Z)*Z)} \\
& - \frac{(3*exp(-3*Z - Y.*Z)*S4.*Y.^2*Z^2)/(2*\exp(4*Z)*Z) + (4*exp(-2*Z - Y.*Z)*S4.*Y.^2*Z^2)/(2*\exp(4*Z)*Z) - (exp(-Z - Y.*Z)*S4.*Y.^2*Z^2)/(2*\exp(4*Z)*Z) + (3*S4.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) ...}{(3*exp(-3*Z - Y.*Z)*S4.*Y.^2*Z^2)/(2*\exp(4*Z)*Z) + (4*exp(-2*Z - Y.*Z)*S4.*Y.^2*Z^2)/(2*\exp(4*Z)*Z) - (exp(-Z - Y.*Z)*S4.*Y.^2*Z^2)/(2*\exp(4*Z)*Z) + (3*S4.*Y.^2*Z^2)/(2*\exp(3*Z)*Z)} \\
& - \frac{(4*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) - (3*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (4*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) - (exp(-Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (3*S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) ...}{(4*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) - (3*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (4*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) - (exp(-Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (3*S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z)} \\
& - \frac{(exp(-Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) - (3*S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) - (3*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (4*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) - (exp(-Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (3*S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) ...}{(exp(-Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) - (3*S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) - (3*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (4*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) - (exp(-Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (3*S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z)} \\
& - \frac{(exp(-Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) - (3*S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) - (3*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (4*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) - (exp(-Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (3*S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) ...}{(exp(-Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) - (3*S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) - (3*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (4*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) - (exp(-Z - Y.*Z)*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (3*S4^2.*Y.^2*Z^2)/(2*\exp(2*Z)*Z)} \\
& + \frac{(2*S4.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (S4.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) - (3*S4^2.*Y.^2*Z^2)/(2*\exp(4*Z)*Z) + (4*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) ...}{(2*S4.*Y.^2*Z^2)/(2*\exp(3*Z)*Z) + (S4.*Y.^2*Z^2)/(2*\exp(2*Z)*Z) - (3*S4^2.*Y.^2*Z^2)/(2*\exp(4*Z)*Z) + (4*S4^2.*Y.^2*Z^2)/(2*\exp(3*Z)*Z)}
\end{aligned}$$

$$\begin{aligned}
& + \frac{(S4^2.*Y.^2*Z*(S_v))/(2*\exp(2*Z))}{(S4^2.*Y.^3*Z*(S_v))/\exp(2*Z)} - \frac{(2*S4.*Y.^3*Z*(S_v))/\exp(2*Z)}{(S4^2.*Y.^4*Z*(S_v))/\exp(2*Z)} \\
& \dots + \frac{(S4.*Y.^4*Z*(S_v))/(4*\exp(2*Z))}{(S4^2.*Y.^4*Z*(S_v))/\exp(3*Z)} + \frac{(3*S4^2.*Y.^4*Z*(S_v))/(4*\exp(4*Z))}{(S4^2.*Y.^4*Z*(S_v))/\exp(3*Z)} \\
& \dots + \frac{(S4^2*Z^2*(S_v))/(2*\exp(3*Z))}{(S4^2.*Y.^2*Z^2*(S_v))/\exp(3*Z)} - \frac{(S4.*Y.^2*Z^2*(S_v))/\exp(3*Z)}{(S4^2.*Y.^2*Z^2*(S_v))/\exp(3*Z)} \\
& \dots + \frac{(S4^2.*Y.^4*Z^2*(S_v))/(2*\exp(3*Z))}{(23*S4^2*(S_v)^2)/(8*\exp(4*Z))} + \frac{(9*S4^2*(S_v)^2)/(16*\exp(6*Z))}{(2*S4^2*(S_v)^2)/\exp(3*Z)} \\
& - \frac{(\exp(-2*Z) - 2.*Y.*Z)*S4^2*(S_v)^2/2}{(2*S4^2.*Y.^2*(S_v)^2)/(2*\exp(2*Z))} - \frac{\exp(-3*Z) - Y.*Z)*S4^2*(S_v)^2}{(S4^2.*Y.^2*(S_v)^2)/(8*\exp(6*Z))} \\
& \dots - \frac{(3*S4^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z))}{(7*S4^2.*Y.^2*(S_v)^2)/(2*\exp(3*Z))} + \frac{(11*S4^2.*Y.^2*(S_v)^2)/(2*\exp(4*Z))}{(15*S4^2.*Y.^2*(S_v)^2)/(8*\exp(2*Z))} \\
& + \frac{(\exp(-2*Z) - 2.*Y.*Z)*S4^2.*Y.^2*(S_v)^2/2}{(3*S4^2.*Y.^3*(S_v)^2)/\exp(4*Z)} + \frac{\exp(-3*Z) - Y.*Z)*S4^2.*Y.^2*(S_v)^2}{(3*S4^2.*Y.^3*(S_v)^2)/(3*\exp(3*Z))} \\
& - \frac{(S4^2.*Y.^3*(S_v)^2)/(2*\exp(2*Z))}{(9*S4^2*(S_v)^2)/(4*\exp(6*Z)*Z^4)} + \frac{(9*S4^2.*Y.^4*(S_v)^2)/(16*\exp(6*Z))}{(6*S4^2*(S_v)^2)/(\exp(5*Z)*Z^4)} \\
& + \frac{(11*S4^2*(S_v)^2)/(2*\exp(4*Z)*Z^4)}{(S4^2*(S_v)^2)/(4*\exp(2*Z)*Z^4)} - \frac{(2*S4^2*(S_v)^2)/(\exp(3*Z)*Z^4)}{(S4^2*(S_v)^2)/(4*\exp(2.*Y.*Z)*Z^4)} \\
& + \frac{(9*\exp(-4*Z) - 2.*Y.*Z)*S4^2*(S_v)^2/(4*Z^4)}{(11*\exp(-3*Z) - 2.*Y.*Z)*S4^2*(S_v)^2/(2*Z^4)} - \frac{(6*\exp(-3*Z) - 2.*Y.*Z)*S4^2*(S_v)^2/Z^4}{(11*\exp(-2*Z) - 2.*Y.*Z)*S4^2*(S_v)^2/(2*Z^4)} \\
& - \frac{(2*\exp(-Z) - 2.*Y.*Z)*S4^2*(S_v)^2/Z^4}{(S4^2*(S_v)^2)/(2*\exp(Z)*Z^3)} - \frac{(9*\exp(-5*Z) - Y.*Z)*S4^2*(S_v)^2/(2*Z^4)}{(9*\exp(-4*Z) - Y.*Z)*S4^2*(S_v)^2/Z^4} + \frac{(12*\exp(-4*Z) - Y.*Z)*S4^2*(S_v)^2/Z^4}{(11*\exp(-3*Z) - 2.*Y.*Z)*S4^2*(S_v)^2/Z^4} \\
& + \frac{(4*\exp(-2*Z) - Y.*Z)*S4^2*(S_v)^2/Z^4}{(12*S4^2*(S_v)^2)/(\exp(5*Z)*Z^3)} - \frac{(\exp(-Z) - Y.*Z)*S4^2*(S_v)^2/(2*Z^4)}{(22*S4^2*(S_v)^2)/(\exp(4*Z)*Z^3)} \\
& + \frac{(27*S4^2*(S_v)^2)/(2*\exp(3*Z)*Z^3)}{(S4^2*(S_v)^2)/(2*\exp(3.*Y.*Z)*Z^3)} - \frac{(4*S4^2*(S_v)^2)/(\exp(2*Z)*Z^3)}{(S4^2*(S_v)^2)/(2*\exp(3.*Y.*Z)*Z^3)} \\
& - \frac{(S4^2*(S_v)^2)/(2*\exp(Y.*Z)*Z^3)}{(S4^2*(S_v)^2)/(2*\exp(-2*Z) - 3.*Y.*Z)*S4^2*(S_v)^2/(2*Z^3)} + \frac{(2*\exp(-Z) - 3.*Y.*Z)*S4^2*(S_v)^2/(2*Z^3)}{(3.*Y.*Z)*S4^2*(S_v)^2/Z^3} \\
& + \frac{(2*\exp(-2*Z) - 2.*Y.*Z)*S4^2*(S_v)^2/Z^3}{(3*\exp(-3*Z) - 2.*Y.*Z)*S4^2*(S_v)^2/(2*Z^3)} - \frac{(\exp(-Z) - 2.*Y.*Z)*S4^2*(S_v)^2/(2*Z^3)}{(9*\exp(-4*Z) - Y.*Z)*S4^2*(S_v)^2/Z^3} \\
& - \frac{(4*\exp(-2*Z) - Y.*Z)*S4^2*(S_v)^2/Z^3}{(18*\exp(-3*Z) - Y.*Z)*S4^2*(S_v)^2/Z^3} + \frac{(25*\exp(-2*Z) - Y.*Z)*S4^2*(S_v)^2/(2*Z^3)}{(9*S4^2.*Y.^(S_v)^2)/(2*\exp(5*Z)*Z^3)} \\
& - \frac{(11*S4^2.*Y.^(S_v)^2)/(2*\exp(3*Z)*Z^3)}{(12*S4^2.*Y.^(S_v)^2)/(\exp(4*Z)*Z^3)} + \frac{(4*\exp(-Z) - Y.*Z)*S4^2*(S_v)^2/Z^3}{(S4^2.*Y.^(S_v)^2)/(2*\exp(Z)*Z^3)} \\
& + \frac{(4*\exp(-2*Z) - 2.*Y.*Z)*S4^2.*Y.^(S_v)^2/(2*Z^3)}{(S4^2.*Y.^(S_v)^2)/(2*\exp(2*Z)*Z^3)} - \frac{(12*\exp(-3*Z) - Y.*Z)*S4^2.*Y.^(S_v)^2/Z^3}{(11*\exp(-2*Z) - Y.*Z)*S4^2.*Y.^(S_v)^2/Z^3} \\
& - \frac{(4*\exp(-Z) - Y.*Z)*S4^2.*Y.^(S_v)^2/Z^3}{(9*S4^2*(S_v)^2)/(4*\exp(6*Z)*Z^2)} + \frac{(S4^2.*Y.^(S_v)^2)/(2*\exp(5*Z)*Z^2)}{(9*S4^2*(S_v)^2)/(4*\exp(6*Z)*Z^2)} \\
& \dots - \frac{(19*S4^2*(S_v)^2)/(2*\exp(4*Z)*Z^2)}{(19*S4^2*(S_v)^2)/(\exp(4*Z)*Z^2)} + \frac{(35*S4^2*(S_v)^2)/(4*\exp(2*Z)*Z^2)}{(2*S4^2*(S_v)^2)/(\exp(Z)*Z^2)} \\
& - \frac{(S4^2*(S_v)^2)/(2*\exp(3*Z)*Z^2)}{(S4^2*(S_v)^2)/(2*\exp(2*Y.*Z)*Z^2)} + \frac{(3*S4^2*(S_v)^2)/(4*\exp(4*Y.*Z)*Z^2)}{(S4^2*(S_v)^2)/(4*\exp(4*Y.*Z)*Z^2)} \\
& + \frac{(S4^2*(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2)}{(S4^2*(S_v)^2)/(2*\exp(-Z) - 2.*Y.*Z)*S4^2*(S_v)^2/Z^2} + \frac{(5*\exp(-2*Z) - 2.*Y.*Z)*S4^2*(S_v)^2/Z^2}{(5*\exp(-2*Z) - 2.*Y.*Z)*S4^2*(S_v)^2/Z^2} \\
& - \frac{(9*\exp(-5*Z) - Y.*Z)*S4^2*(S_v)^2/(4*Z^2)}{(9*\exp(-3*Z) - Y.*Z)*S4^2*(S_v)^2/Z^2} + \frac{(3*\exp(-4*Z) - Y.*Z)*S4^2*(S_v)^2/Z^2}{(3*\exp(-3*Z) - Y.*Z)*S4^2*(S_v)^2/Z^2} + \frac{(5*\exp(-3*Z) - Y.*Z)*S4^2*(S_v)^2/Z^2}{(3*\exp(-3*Z) - Y.*Z)*S4^2*(S_v)^2/Z^2} \\
& + \frac{(\exp(-Z) - Y.*Z)*S4^2*(S_v)^2/(4*Z^2)}{(15*S4^2.*Y.^(S_v)^2)/(\exp(4*Z)*Z^2)} - \frac{(26*S4^2.*Y.^(S_v)^2)/(\exp(3*Z)*Z^2)}{(15*S4^2.*Y.^(S_v)^2)/(\exp(4*Z)*Z^2)} \\
& - \frac{(29*S4^2.*Y.^(S_v)^2)/(2*\exp(2*Z)*Z^2)}{(S4^2.*Y.^(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2)} + \frac{(4*S4^2.*Y.^(S_v)^2)/(\exp(Z)*Z^2)}{(S4^2.*Y.^(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2)} \\
& + \frac{(2*\exp(-Z) - 2.*Y.*Z)*S4^2.*Y.^(S_v)^2/Z^2}{(2*\exp(-Z) - 2.*Y.*Z)*S4^2.*Y.^(S_v)^2/Z^2} + \frac{(S4^2.*Y.^2*(S_v)^2)/(4*Z^2)}{(S4^2.*Y.^2*(S_v)^2)/(4*Z^2)} \\
& (9*S4^2.*Y.^2*(S_v)^2)/(4*\exp(6*Z)*Z^2) - \frac{(6*S4^2.*Y.^2*(S_v)^2)/(\exp(5*Z)*Z^2)}{(9*S4^2.*Y.^2*(S_v)^2)/(4*\exp(6*Z)*Z^2)}
\end{aligned}$$

$$\begin{aligned}
& + (31*S4^2.*Y.^2*(S_v)^2)/(4*exp(4*Z)*Z^2) - (8*S4^2.*Y.^2*(S_v)^2)/(exp(3*Z)*Z^2) + \\
& (23*S4^2.*Y.^2*(S_v)^2)/(4*exp(2*Z)*Z^2) - (2*S4^2.*Y.^2*(S_v)^2)/(exp(Z)*Z^2) \dots \\
& - (9*exp(-5*Z - Y.*Z)*S4^2.*Y.^2*(S_v)^2)/(4*Z^2) + (6*exp(-4*Z - Y.*Z)*S4^2.*Y.^2*(S_v)^2)/Z^2 \\
& - (11*exp(-3*Z - Y.*Z)*S4^2.*Y.^2*(S_v)^2)/(2*Z^2) \dots \\
& + (2*exp(-2*Z - Y.*Z)*S4^2.*Y.^2*(S_v)^2)/Z^2 - (exp(-Z - Y.*Z)*S4^2.*Y.^2*(S_v)^2)/(4*Z^2) + \\
& (9*S4^2*(S_v)^2)/(2*exp(5*Z)*Z) - (S4^2*(S_v)^2)/(exp(4*Z)*Z) \dots \\
& + (25*S4^2*(S_v)^2)/(4*exp(3*Z)*Z) - (3*S4^2*(S_v)^2)/(exp(2*Z)*Z) + \\
& (3*S4^2*(S_v)^2)/(4*exp(Z)*Z) + (3*exp(-3*Z - 2.*Y.*Z)*S4^2*(S_v)^2)/(4*Z) \dots \\
& + (3*exp(-Z - 2.*Y.*Z)*S4^2*(S_v)^2)/(4*Z) + (3*exp(-4*Z - Y.*Z)*S4^2*(S_v)^2)/(4*Z^2) + \\
& (3*S4^2*(S_v)^2)/(4*exp(3*Z)*Z) + (3*exp(-2*Z - 2.*Y.*Z)*S4^2*(S_v)^2)/(4*Z) - (2*exp(-3*Z - \\
& Y.*Z)*S4^2*(S_v)^2)/Z + (2*exp(-2*Z - Y.*Z)*S4^2*(S_v)^2)/Z \dots \\
& - (9*S4^2.*Y.(S_v)^2)/(4*exp(5*Z)*Z) + (3*S4^2.*Y.(S_v)^2)/(exp(4*Z)*Z) - \\
& (11*S4^2.*Y.(S_v)^2)/(exp(3*Z)*Z) + (7*S4^2.*Y.(S_v)^2)/(exp(2*Z)*Z) \dots \\
& - (7*S4^2.*Y.(S_v)^2)/(4*exp(Z)*Z) - (exp(-Z - 2.*Y.*Z)*S4^2.*Y.(S_v)^2)/Z - (2*exp(-2*Z - \\
& Y.*Z)*S4^2.*Y.(S_v)^2)/Z + (15*S4^2.*Y.^2*(S_v)^2)/(2*exp(5*Z)*Z) \dots \\
& - (13*S4^2.*Y.^2*(S_v)^2)/(exp(4*Z)*Z) + (41*S4^2.*Y.^2*(S_v)^2)/(4*exp(3*Z)*Z) - \\
& (6*S4^2.*Y.^2*(S_v)^2)/(exp(2*Z)*Z) + (5*S4^2.*Y.^2*(S_v)^2)/(4*exp(Z)*Z) \dots \\
& + (3*exp(-3*Z - 2.*Y.*Z)*S4^2.*Y.^2*(S_v)^2)/(4*Z) - (exp(-2*Z - 2.*Y.*Z)*S4^2.*Y.^2*(S_v)^2)/Z \\
& + (exp(-Z - 2.*Y.*Z)*S4^2.*Y.^2*(S_v)^2)/(4*Z) \dots \\
& - (9*S4^2.*Y.^3*(S_v)^2)/(4*exp(5*Z)*Z) + (6*S4^2.*Y.^3*(S_v)^2)/(exp(4*Z)*Z) - \\
& (11*S4^2.*Y.^3*(S_v)^2)/(2*exp(3*Z)*Z) + (2*S4^2.*Y.^3*(S_v)^2)/(exp(2*Z)*Z) \dots \\
& - (S4^2.*Y.^3*(S_v)^2)/(4*exp(Z)*Z) - (3*S4^2*Z*(S_v)^2)/(4*exp(5*Z)) - \\
& (3*S4^2*Z*(S_v)^2)/(4*exp(3*Z)) + (S4^2.*Y.^2*(S_v)^2)/(exp(3*Z)) + \\
& (S4^2.*Y.^2*Z*(S_v)^2)/(exp(4*Z)) \dots \\
& + (S4^2.*Y.^2*Z*(S_v)^2)/(2*exp(3*Z)) - (S4^2.*Y.^3*Z*(S_v)^2)/(exp(3*Z)) + \\
& (3*S4^2.*Y.^4*Z*(S_v)^2)/(4*exp(5*Z)) - (S4^2.*Y.^4*Z*(S_v)^2)/(exp(4*Z)) \dots \\
& + (S4^2.*Y.^4*Z*(S_v)^2)/(4*exp(3*Z)) + (S4^2*Z^2*(S_v)^2)/(4*exp(4*Z)) - \\
& (S4^2.*Y.^2*Z^2*(S_v)^2)/(2*exp(4*Z)) + (S4^2.*Y.^4*Z^2*(S_v)^2)/(4*exp(4*Z));
\end{aligned}$$

Ns4=Nf+Nc+Ny4;  
 Phi4=Nf./[Nc+Ny4];  
 Be4=1./[1+Phi4];  
 Gf4=Nf./Ns4;  
 Gh4=[Nc+Ny4]./Ns4;  
 Nh4=Nc+Ny4;

$$\begin{aligned}
S5=5; \\
Ny5=1 - exp(-2*Z) + exp(-Z - Y.*Z) - (2*S5)/exp(2*Z) + 2*exp(-Z - Y.*Z)*S5 - S5^2/exp(2*Z) + exp(-Z - \\
Y.*Z)*S5^2 - 2.*Y + Y.^2 + Y.^2/2/exp(2*Z) - exp(-Z - Y.*Z).*Y.^2 \dots \\
+ (2*S5.*Y.^2)/exp(2*Z) - 2*exp(-Z - Y.*Z)*S5.*Y.^2 + (S5^2.*Y.^2)/exp(2*Z) - exp(-Z - \\
Y.*Z)*S5^2.*Y.^2 + 1/(exp(2*Z)*Z^2) + 1.//(exp(2.*Y.*Z)*Z^2) \dots \\
- (2*exp(-Z - Y.*Z))/Z^2 + (2*S5)/(exp(2*Z)*Z^2) + (2*S5).//(exp(2.*Y.*Z)*Z^2) - (4*exp(-Z - \\
Y.*Z)*S5)/Z^2 + S5^2/(exp(2*Z)*Z^2) + S5^2.//(exp(2.*Y.*Z)*Z^2) \dots \\
- (2*exp(-Z - Y.*Z)*S5^2)/Z^2 + 2/(exp(Z)*Z) - 2.//(exp(Y.*Z)*Z) + (2*S5)/(exp(Z)*Z) - \\
(2*S5).//(exp(Y.*Z)*Z) - (2.*Y)/(exp(Z)*Z) + (2.*Y)/(exp(Y.*Z)*Z) \dots \\
- (2*S5.*Y)/(exp(Z)*Z) + (2*S5.*Y)/(exp(Y.*Z)*Z) - Z/exp(Z) - (S5*Z)/exp(Z) + (Y.*Z)/exp(Z) + \\
(S5.*Y.*Z)/exp(Z) + (Y.^2*Z)/exp(Z) + (S5.*Y.^2*Z)/exp(Z) - (Y.^3*Z)/exp(Z) \dots \\
- (S5.*Y.^3*Z)/exp(Z) + Z^2/(4*exp(2*Z)) + (S5*Z^2)/(2*exp(2*Z)) + (S5^2*Z^2)/(4*exp(2*Z)) - \\
(Y.^2*Z^2)/(2*exp(2*Z)) - (S5.*Y.^2*Z^2)/exp(2*Z) \dots \\
- (S5^2.*Y.^2*Z^2)/(2*exp(2*Z)) + (Y.^4*Z^2)/(4*exp(2*Z)) + (S5.*Y.^4*Z^2)/(2*exp(2*Z)) + \\
(S5^2.*Y.^4*Z^2)/(4*exp(2*Z)) - (7*S5*(S_v))/(2*exp(3*Z)) \dots \\
+ (2*S5*(S_v))/exp(2*Z) + (S5*(S_v))/exp(Z) - (exp(-Z - 2.*Y.*Z)*S5*(S_v))/2 - \\
(5*S5^2*(S_v))/exp(3*Z) + (2*S5^2*(S_v))/exp(2*Z) - (S5^2*(S_v))/(2*exp(Z)) \dots \\
- (exp(-Z - 2.*Y.*Z)*S5^2*(S_v))/2 - (2*S5.*Y.(S_v))/exp(2*Z) - (3*S5.*Y.(S_v))/exp(Z) + \\
(3*S5^2.*Y.(S_v))/(2*exp(3*Z)) - (2*S5^2.*Y.(S_v))/exp(2*Z) \dots
\end{aligned}$$

$$\begin{aligned}
& + (S5^2.*Y.^(S_v))/(2*exp(Z)) + (13*S5.*Y.^2*(S_v))/(2*exp(3*Z)) - (4*S5.*Y.^2*(S_v))/exp(2*Z) + \\
& (3*S5.*Y.^2*(S_v))/exp(Z) + (exp(-Z - 2.*Y.*Z)*S5.*Y.^2*(S_v))/2 ... \\
& + (5*S5^2.*Y.^2*(S_v))/exp(3*Z) - (2*S5^2.*Y.^2*(S_v))/exp(2*Z) + (S5^2.*Y.^2*(S_v))/(2*exp(Z)) \\
& + (exp(-Z - 2.*Y.*Z)*S5^2.*Y.^2*(S_v))/2 - (3*S5.*Y.^3*(S_v))/exp(3*Z) ... \\
& + (4*S5.*Y.^3*(S_v))/exp(2*Z) - (S5.*Y.^3*(S_v))/exp(Z) - (3*S5^2.*Y.^3*(S_v))/(2*exp(3*Z)) + \\
& (2*S5^2.*Y.^3*(S_v))/exp(2*Z) - (S5^2.*Y.^3*(S_v))/(2*exp(Z)) ... \\
& + (3*S5*(S_v))/(exp(4*Z)*Z^3) - (4*S5*(S_v))/(exp(3*Z)*Z^3) + (S5*(S_v))/(exp(2*Z)*Z^3) + \\
& (S5*(S_v))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S5*(S_v))/Z^3 ... \\
& - (4*exp(-Z - 2.*Y.*Z)*S5*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S5*(S_v))/Z^3 + (8*exp(-2*Z - \\
& Y.*Z)*S5*(S_v))/Z^3 - (2*exp(-Z - Y.*Z)*S5*(S_v))/Z^3 ... \\
& + (3*S5^2*(S_v))/(exp(4*Z)*Z^3) - (4*S5^2*(S_v))/(exp(3*Z)*Z^3) + (S5^2*(S_v))/(exp(2*Z)*Z^3) + \\
& (S5^2*(S_v))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S5^2*(S_v))/Z^3 ... \\
& - (4*exp(-Z - 2.*Y.*Z)*S5^2*(S_v))/Z^3 - (6*exp(-3*Z - Y.*Z)*S5^2*(S_v))/Z^3 + (8*exp(-2*Z - \\
& Y.*Z)*S5^2*(S_v))/Z^3 - (2*exp(-Z - Y.*Z)*S5^2*(S_v))/Z^3 ... \\
& + (11*S5*(S_v))/(exp(3*Z)*Z^2) - (8*S5*(S_v))/(exp(2*Z)*Z^2) + (2*S5*(S_v))/(exp(Z)*Z^2) - \\
& (S5*(S_v))./(exp(3.*Y.*Z)*Z^2) - (2*S5*(S_v))./(exp(Y.*Z)*Z^2) ... \\
& - (exp(-Z - 2.*Y.*Z)*S5*(S_v))/Z^2 - (9*exp(-2*Z - Y.*Z)*S5*(S_v))/Z^2 + (8*exp(-Z - \\
& Y.*Z)*S5*(S_v))/Z^2 + (8*S5^2*(S_v))/(exp(3*Z)*Z^2); ... \\
& - (4*S5^2*(S_v))/(exp(2*Z)*Z^2) + (S5^2*(S_v))/(exp(Z)*Z^2) - (S5^2*(S_v))./(exp(3.*Y.*Z)*Z^2) - \\
& (S5^2*(S_v))./(exp(Y.*Z)*Z^2) - (exp(-Z - 2.*Y.*Z)*S5^2*(S_v))/Z^2 ... \\
& - (6*exp(-2*Z - Y.*Z)*S5^2*(S_v))/Z^2 + (4*exp(-Z - Y.*Z)*S5^2*(S_v))/Z^2 - \\
& (6*S5.*Y.^(S_v))/(exp(3*Z)*Z^2) + (8*S5.*Y.^(S_v))/(exp(2*Z)*Z^2) ... \\
& - (2*S5.*Y.^(S_v))/(exp(Z)*Z^2) + (2*S5.*Y.^(S_v))/(exp(Y.*Z)*Z^2) + (6*exp(-2*Z - \\
& Y.*Z)*S5.*Y.^(S_v))/Z^2 - (8*exp(-Z - Y.*Z)*S5.*Y.^(S_v))/Z^2 ... \\
& - (3*S5^2.*Y.^(S_v))/(exp(3*Z)*Z^2) + (4*S5^2.*Y.^(S_v))/(exp(2*Z)*Z^2) ... \\
& (S5^2.*Y.^(S_v))/(exp(Z)*Z^2) + (S5^2.*Y.^(S_v))/(exp(Y.*Z)*Z^2) ... \\
& + (3*exp(-2*Z - Y.*Z)*S5^2.*Y.^(S_v))/Z^2 - (4*exp(-Z - Y.*Z)*S5^2.*Y.^(S_v))/Z^2 + (S5*(S_v))/Z \\
& + (2*S5*(S_v))/(exp(3*Z)*Z) + (9*S5*(S_v))/(exp(2*Z)*Z)... \\
& - (4*S5*(S_v))/(exp(Z)*Z) + (S5*(S_v))./(exp(2.*Y.*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S5*(S_v))/Z + \\
& (exp(-Z - Y.*Z)*S5*(S_v))/Z + (2*S5^2*(S_v))/(exp(3*Z)*Z) ... \\
& + (S5^2*(S_v))/(exp(2*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S5^2*(S_v))/Z - (exp(-Z - Y.*Z)*S5^2*(S_v))/Z - \\
& (2*S5.*Y.^(S_v))/Z - (13*S5.*Y.^(S_v))/(exp(2*Z)*Z) ... \\
& + (8*S5.*Y.^(S_v))/(exp(Z)*Z) - (S5.*Y.^(S_v))./(exp(2.*Y.*Z)*Z) ... \\
& (2*S5^2.*Y.^(S_v))/(exp(2*Z)*Z) + (2*exp(-Z - Y.*Z)*S5^2.*Y.^(S_v))/Z + (S5.*Y.^2*(S_v))/Z ... \\
& + (3*S5.*Y.^2*(S_v))/(exp(4*Z)*Z) - (4*S5.*Y.^2*(S_v))/(exp(3*Z)*Z) ... \\
& (4*S5.*Y.^2*(S_v))/(exp(2*Z)*Z) - (4*S5.*Y.^2*(S_v))/(exp(Z)*Z) ... \\
& - (3*exp(-3*Z - Y.*Z)*S5.*Y.^2*(S_v))/Z + (4*exp(-2*Z - Y.*Z)*S5.*Y.^2*(S_v))/Z - (exp(-Z - \\
& Y.*Z)*S5.*Y.^2*(S_v))/Z + (3*S5^2.*Y.^2*(S_v))/(exp(4*Z)*Z) ... \\
& - (4*S5^2.*Y.^2*(S_v))/(exp(3*Z)*Z) + (S5^2.*Y.^2*(S_v))/(exp(2*Z)*Z) - (3*exp(-3*Z - \\
& Y.*Z)*S5^2.*Y.^2*(S_v))/Z + (4*exp(-2*Z - Y.*Z)*S5^2.*Y.^2*(S_v))/Z ... \\
& - (exp(-Z - Y.*Z)*S5^2.*Y.^2*(S_v))/Z - (3*S5^2.*Y.^2*(S_v))/(4*exp(4*Z)) - (7*S5^2.*Y.^2*(S_v))/(4*exp(2*Z)) \\
& - (3*S5^2.*Y.^2*(S_v))/(4*exp(4*Z)) - (3*S5^2.*Y.^2*(S_v))/(4*exp(2*Z)) ... \\
& + (2*S5.*Y.^2*(S_v))/(exp(2*Z) + (S5^2.*Y.^2*(S_v))/(exp(2*Z) + (S5.*Y.^2*(S_v))/exp(3*Z) + \\
& (3*S5.*Y.^2*(S_v))/(2*exp(2*Z)) + (S5^2.*Y.^2*(S_v))/(exp(3*Z)) ... \\
& + (S5^2.*Y.^2*(S_v))/(2*exp(2*Z)) - (2*S5.*Y.^3*(S_v))/exp(2*Z) ... \\
& (S5^2.*Y.^3*(S_v))/exp(2*Z) + (3*S5.*Y.^4*(S_v))/(4*exp(4*Z)) - (S5.*Y.^4*(S_v))/exp(3*Z) ... \\
& ... \\
& + (S5.*Y.^4*(S_v))/(4*exp(2*Z)) + (3*S5^2.*Y.^4*(S_v))/(4*exp(4*Z)) - \\
& (S5^2.*Y.^4*(S_v))/exp(3*Z) + (S5^2.*Y.^4*(S_v))/(4*exp(2*Z)) + (S5^2.*Y.^2*(S_v))/(2*exp(3*Z)) ... \\
& ... \\
& + (S5^2.*Y.^2*(S_v))/(2*exp(3*Z)) - (S5.*Y.^2*(S_v))/exp(3*Z) ... \\
& (S5^2.*Y.^2*(S_v))/exp(3*Z) + (S5.*Y.^2*(S_v))/exp(3*Z) ... \\
& + (S5^2.*Y.^2*(S_v))/(2*exp(3*Z)) + (9*S5^2*(S_v)^2)/(16*exp(6*Z)) ... \\
& (23*S5^2*(S_v)^2)/(8*exp(4*Z)) + (2*S5^2*(S_v)^2)/exp(3*Z) + (S5^2*(S_v)^2)/(16*exp(2*Z)) ...
\end{aligned}$$

$$\begin{aligned}
& - (\exp(-2*Z) - 2.*Y.*Z)*S5^2*(S_v)^2/2 - \exp(-3*Z) - Y.*Z)*S5^2*(S_v)^2 \\
& -(2*S5^2*Y.)*(S_v)^2)/\exp(3*Z) - (S5^2.*Y.)*(S_v)^2)/\exp(2*Z) + (9*S5^2.*Y.^2*(S_v)^2)/(8*\exp(6*Z)) \\
& \dots \\
& - (3*S5^2.*Y.^2*(S_v)^2)/(2*\exp(5*Z)) + (11*S5^2.*Y.^2*(S_v)^2)/(2*\exp(4*Z)) - \\
& (7*S5^2.*Y.^2*(S_v)^2)/(2*\exp(3*Z)) + (15*S5^2.*Y.^2*(S_v)^2)/(8*\exp(2*Z)) \dots \\
& + (\exp(-2*Z) - 2.*Y.*Z)*S5^2.*Y.^2*(S_v)^2/2 + \exp(-3*Z) - Y.*Z)*S5^2.*Y.^2*(S_v)^2 \\
& -(3*S5^2.*Y.^3*(S_v)^2)/\exp(4*Z) + (4*S5^2.*Y.^3*(S_v)^2)/\exp(3*Z) \dots \\
& - (S5^2.*Y.^3*(S_v)^2)/\exp(2*Z) + (9*S5^2.*Y.^4*(S_v)^2)/(16*\exp(6*Z)) \\
& -(3*S5^2.*Y.^4*(S_v)^2)/(2*\exp(5*Z)) + (11*S5^2.*Y.^4*(S_v)^2)/(8*\exp(4*Z)) \dots \\
& - (S5^2.*Y.^4*(S_v)^2)/(2*\exp(3*Z)) + (S5^2.*Y.^4*(S_v)^2)/(16*\exp(2*Z)) \\
& (9*S5^2*(S_v)^2)/(4*\exp(6*Z)*Z^4) - (6*S5^2*(S_v)^2)/(\exp(5*Z)*Z^4) \dots \\
& + (11*S5^2*(S_v)^2)/(2*\exp(4*Z)*Z^4) - (2*S5^2*(S_v)^2)/(\exp(3*Z)*Z^4) \\
& (S5^2*(S_v)^2)/(4*\exp(2*Z)*Z^4) + (S5^2*(S_v)^2)/(4*\exp(2*Y.*Z)*Z^4) \dots \\
& + (9*\exp(-4*Z) - 2.*Y.*Z)*S5^2*(S_v)^2)/(4*Z^4) - (6*\exp(-3*Z) - 2.*Y.*Z)*S5^2*(S_v)^2/Z^4 + \\
& (11*\exp(-2*Z) - 2.*Y.*Z)*S5^2*(S_v)^2)/(2*Z^4) \dots \\
& - (2*\exp(-Z) - 2.*Y.*Z)*S5^2*(S_v)^2)/Z^4 - (9*\exp(-5*Z) - Y.*Z)*S5^2*(S_v)^2)/(2*Z^4) + (12*\exp(- \\
& 4*Z) - Y.*Z)*S5^2*(S_v)^2)/Z^4 - (11*\exp(-3*Z) - Y.*Z)*S5^2*(S_v)^2)/Z^4 \dots \\
& + (4*\exp(-2*Z) - Y.*Z)*S5^2*(S_v)^2)/Z^4 - (\exp(-Z) - Y.*Z)*S5^2*(S_v)^2)/(2*Z^4) \\
& (12*S5^2*(S_v)^2)/(\exp(5*Z)*Z^3) - (22*S5^2*(S_v)^2)/(\exp(4*Z)*Z^3) \dots \\
& + (27*S5^2*(S_v)^2)/(2*\exp(3*Z)*Z^3) - (4*S5^2*(S_v)^2)/(\exp(2*Z)*Z^3) \\
& (S5^2*(S_v)^2)/(2*\exp(Z)*Z^3) - (S5^2*(S_v)^2)/(2*\exp(3.*Y.*Z)*Z^3) \dots \\
& - (S5^2*(S_v)^2)/(2*\exp(Y.*Z)*Z^3) - (3*\exp(-2*Z) - 3.*Y.*Z)*S5^2*(S_v)^2)/(2*Z^3) + (2*\exp(-Z) - \\
& 3.*Y.*Z)*S5^2*(S_v)^2)/Z^3 - (3*\exp(-3*Z) - 2.*Y.*Z)*S5^2*(S_v)^2)/(2*Z^3) \dots \\
& + (2*\exp(-2*Z) - 2.*Y.*Z)*S5^2*(S_v)^2)/Z^3 - (\exp(-Z) - 2.*Y.*Z)*S5^2*(S_v)^2)/(2*Z^3) - (9*\exp(- \\
& 4*Z) - Y.*Z)*S5^2*(S_v)^2)/Z^3 + (18*\exp(-3*Z) - Y.*Z)*S5^2*(S_v)^2)/Z^3 \dots \\
& - (25*\exp(-2*Z) - Y.*Z)*S5^2*(S_v)^2)/(2*Z^3) + (4*\exp(-Z) - Y.*Z)*S5^2*(S_v)^2)/(Z^3) - \\
& (9*S5^2.*Y.)*(S_v)^2)/(2*\exp(5*Z)*Z^3) + (12*S5^2.*Y.)*(S_v)^2)/(\exp(4*Z)*Z^3) \dots \\
& - (11*S5^2.*Y.)*(S_v)^2)/(exp(3*Z)*Z^3) + (4*S5^2.*Y.)*(S_v)^2)/(\exp(2*Z)*Z^3) \\
& (S5^2.*Y.)*(S_v)^2)/(2*\exp(Z)*Z^3) + (S5^2.*Y.)*(S_v)^2)/(2*\exp(Y.*Z)*Z^3) \dots \\
& + (9*\exp(-4*Z) - Y.*Z)*S5^2.*Y.)*(S_v)^2)/(2*Z^3) - (12*\exp(-3*Z) - Y.*Z)*S5^2.*Y.)*(S_v)^2)/Z^3 + \\
& (11*\exp(-2*Z) - Y.*Z)*S5^2.*Y.)*(S_v)^2)/Z^3 \dots \\
& - (4*\exp(-Z) - Y.*Z)*S5^2.*Y.)*(S_v)^2)/Z^3 + (S5^2*(S_v)^2)/(4*\exp(2*Z)*Z^2) \\
& (9*S5^2*(S_v)^2)/(4*\exp(6*Z)*Z^2) - (3*S5^2*(S_v)^2)/(exp(5*Z)*Z^2) \\
& (19*S5^2*(S_v)^2)/(exp(4*Z)*Z^2) \dots \\
& - (19*S5^2*(S_v)^2)/(exp(3*Z)*Z^2) + (35*S5^2*(S_v)^2)/(4*\exp(2*Z)*Z^2) \\
& (2*S5^2*(S_v)^2)/(exp(Z)*Z^2) + (S5^2*(S_v)^2)/(4*\exp(4.*Y.*Z)*Z^2) \dots \\
& + (S5^2*(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2) + (\exp(-Z) - 3.*Y.*Z)*S5^2*(S_v)^2)/Z^2 + (5*\exp(-2*Z) - \\
& 2.*Y.*Z)*S5^2*(S_v)^2)/Z^2 - (2*\exp(-Z) - 2.*Y.*Z)*S5^2*(S_v)^2)/Z^2 \dots \\
& - (9*\exp(-5*Z) - Y.*Z)*S5^2*(S_v)^2)/(4*Z^2) + (3*\exp(-4*Z) - Y.*Z)*S5^2*(S_v)^2)/Z^2 + (5*\exp(- \\
& 3*Z) - Y.*Z)*S5^2*(S_v)^2)/Z^2 - (\exp(-2*Z) - Y.*Z)*S5^2*(S_v)^2)/Z^2 \dots \\
& + (\exp(-Z) - Y.*Z)*S5^2*(S_v)^2)/(4*Z^2) - (S5^2.*Y.)*(S_v)^2)/(2*Z^2) \\
& (15*S5^2.*Y.)*(S_v)^2)/(exp(4*Z)*Z^2) + (26*S5^2.*Y.)*(S_v)^2)/(exp(3*Z)*Z^2) \dots \\
& - (29*S5^2.*Y.)*(S_v)^2)/(2*\exp(2*Z)*Z^2) + (4*S5^2.*Y.)*(S_v)^2)/(\exp(Z)*Z^2) \\
& (S5^2.*Y.)*(S_v)^2)/(2*\exp(2.*Y.*Z)*Z^2) - (3*\exp(-2*Z) - 2.*Y.*Z)*S5^2.*Y.)*(S_v)^2)/(2*Z^2) \dots \\
& + (2*\exp(-Z) - 2.*Y.*Z)*S5^2.*Y.)*(S_v)^2)/Z^2 + (S5^2.*Y.^2*(S_v)^2)/(4*Z^2) \\
& (9*S5^2.*Y.^2*(S_v)^2)/(4*\exp(6*Z)*Z^2) - (6*S5^2.*Y.^2*(S_v)^2)/(exp(5*Z)*Z^2) \dots \\
& + (31*S5^2.*Y.^2*(S_v)^2)/(4*\exp(4*Z)*Z^2) - (8*S5^2.*Y.^2*(S_v)^2)/(exp(3*Z)*Z^2) \\
& (23*S5^2.*Y.^2*(S_v)^2)/(4*\exp(2*Z)*Z^2) - (2*S5^2.*Y.^2*(S_v)^2)/(exp(Z)*Z^2) \dots \\
& - (9*\exp(-5*Z) - Y.*Z)*S5^2.*Y.^2*(S_v)^2)/(4*Z^2) + (6*\exp(-4*Z) - Y.*Z)*S5^2.*Y.^2*(S_v)^2)/Z^2 \\
& - (11*\exp(-3*Z) - Y.*Z)*S5^2.*Y.^2*(S_v)^2)/(2*Z^2) \dots \\
& + (2*\exp(-2*Z) - Y.*Z)*S5^2.*Y.^2*(S_v)^2)/Z^2 - (\exp(-Z) - Y.*Z)*S5^2.*Y.^2*(S_v)^2)/(4*Z^2) + \\
& (9*S5^2*(S_v)^2)/(2*\exp(5*Z)*Z) - (S5^2*(S_v)^2)/(exp(4*Z)*Z) \dots \\
& + (25*S5^2*(S_v)^2)/(4*\exp(3*Z)*Z) - (3*S5^2*(S_v)^2)/(exp(2*Z)*Z) \\
& (3*S5^2*(S_v)^2)/(4*\exp(Z)*Z) + (3*\exp(-3*Z) - 2.*Y.*Z)*S5^2*(S_v)^2)/(4*Z) \dots \\
& + (3*\exp(-Z) - 2.*Y.*Z)*S5^2*(S_v)^2)/(4*Z) + (3*\exp(-4*Z) - Y.*Z)*S5^2*(S_v)^2)/Z - (2*\exp(-3*Z) - \\
& Y.*Z)*S5^2*(S_v)^2)/Z + (2*\exp(-2*Z) - Y.*Z)*S5^2*(S_v)^2)/Z \dots
\end{aligned}$$

$$\begin{aligned}
& - \frac{(9*S5^2.*Y.*(S_v)^2)/(4*exp(5*Z)*Z)}{(11*S5^2.*Y.*(S_v)^2)/(exp(3*Z)*Z) + (7*S5^2.*Y.*(S_v)^2)/(exp(2*Z)*Z)} \\
& - \frac{(7*S5^2.*Y.*(S_v)^2)/(4*exp(Z)*Z)}{(exp(-Z - 2.*Y.*Z)*S5^2.*Y.*(S_v)^2)/Z} - \frac{(2*exp(-2*Z - Y.*Z)*S5^2.*Y.*(S_v)^2)/Z}{(15*S5^2.*Y.^2*(S_v)^2)/(2*exp(5*Z)*Z)} \\
& - \frac{(13*S5^2.*Y.^2*(S_v)^2)/(exp(4*Z)*Z)}{(6*S5^2.*Y.^2*(S_v)^2)/(exp(2*Z)*Z) + (5*S5^2.*Y.^2*(S_v)^2)/(4*exp(Z)*Z)} \\
& + \frac{(3*exp(-3*Z - 2.*Y.*Z)*S5^2.*Y.^2*(S_v)^2)/(4*Z)}{(exp(-2*Z - 2.*Y.*Z)*S5^2.*Y.^2*(S_v)^2)/(4*exp(3*Z)*Z)} \\
& + (exp(-Z - 2.*Y.*Z)*S5^2.*Y.^2*(S_v)^2)/(4*Z) \\
& - \frac{(9*S5^2.*Y.^3*(S_v)^2)/(4*exp(5*Z)*Z)}{(11*S5^2.*Y.^3*(S_v)^2)/(2*exp(3*Z)*Z) + (2*S5^2.*Y.^3*(S_v)^2)/(exp(2*Z)*Z)} \\
& - \frac{(S5^2.*Y.^3*(S_v)^2)/(4*exp(Z)*Z)}{(3*S5^2*Z*(S_v)^2)/(4*exp(3*Z))} \\
& + \frac{(S5^2.*Y.^2*Z*(S_v)^2)/exp(3*Z)}{(S5^2.*Y.^2*Z*(S_v)^2)/exp(4*Z)} \\
& + \frac{(S5^2.*Y.^2*Z*(S_v)^2)/(2*exp(3*Z))}{(3*S5^2.*Y.^4*Z*(S_v)^2)/(4*exp(5*Z))} \\
& - \frac{(S5^2.*Y.^4*Z*(S_v)^2)/exp(4*Z)}{(S5^2.*Y.^4*Z*(S_v)^2)/(4*exp(3*Z))} \\
& + \frac{(S5^2.*Y.^4*Z*(S_v)^2)/(2*exp(4*Z))}{(S5^2.*Y.^2*Z^2*(S_v)^2)/(4*exp(4*Z))} \\
& + (S5^2.*Y.^4*Z*(S_v)^2)/(4*exp(4*Z));
\end{aligned}$$

Ns5=Nf+Nc+Ny5;  
 Phi5=Nf./[Nc+Ny5];  
 Be5=1./[1+Phi5];  
 Gf5=Nf./Ns5;  
 Gh5=[Nc+Ny5]./Ns5;  
 Nh5=Nc+Ny5;

```

plot(Y,Ns1,'b',Y,Ns2,'g',Y,Ns3,'r',Y,Ns4,'k',Y,Ns5,'m')

% plot(Y,Be1,'b',Y,Be2,'g',Y,Be3,'r',Y,Be4,'k',Y,Be5,'m')

% plot(Y,Phi1,'b',Y,Phi2,'g',Y,Phi3,'r',Y,Phi4,'k',Y,Phi5,'m')

% plot(Y,Gf1,'b',Y,Gf2,'g',Y,Gf3,'r',Y,Gf4,'k',Y,Gf5,'m')

% plot(Y,Gh1,'b',Y,Gh2,'g',Y,Gh3,'r',Y,Gh4,'k',Y,Gh5,'m')

% plot(Y,Nf)

% plot(Y,Nh1,'b',Y,Nh2,'g',Y,Nh3,'r',Y,Nh4,'k',Y,Nh5,'m')

% plot(Nh1,Nf1,'b',Nh2,Nf2,'g',Nh3,Nf3,'r',Nh4,Nf4,'k',Nh5,Nf5,'m')

```

PLOTOOLS ON

**1.5. Distribution of  $N_s$ ,  $Be$ ,  $\Phi$ ,  $G_F$ ,  $G_H$ ,  $N_F$  and  $N_H$  versus  $Y$  for a range of  $S_v$  and set of  $S$ ,  $Z$ ,  $Br$  &  $Pe$**

```

S=1; Z=1; Br=1; Pe=2.5;
% S=1.5; Z=3.5; Br=0.5; Pe=5.5;

% % % % Z=6; S=8; Br=0.6; Pe=7;
% % % % Z=7.5; S=15; Br=0.6; Pe=2.5;
% % % % Z=5; S=0.75; Br=1; Pe=2;
% % % % Z=18; S=25; Br=0.9; Pe=5;

q=1.86;
s=1;
Dh=250*10^-6;
Y=0:0.005:1;

Nc=[1/Pe^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Nf=Br*[(Z^2).*exp(-2.*Y.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-Y.*Z)];
```

$S_{v1}=1;$

$Y_{11} = -\exp(-2*Z) + \exp(-Z - Y.*Z) - (2*S)/\exp(2*Z) + 2*\exp(-Z - Y.*Z)*S - S^2/\exp(2*Z) + \exp(-Z - Y.*Z)*S^2 - 2.*Y + Y.^2 + Y.^2/\exp(2*Z) - \exp(-Z - Y.*Z).*Y.^2 ...$

$+ (2*S.*Y.^2)/\exp(2*Z) - 2*\exp(-Z - Y.*Z)*S.*Y.^2 + (S^2.*Y.^2)/\exp(2*Z) - \exp(-Z - Y.*Z)*S^2.*Y.^2 + 1/(\exp(2*Z)*Z^2) + 1. / (\exp(2.*Y.*Z)*Z^2) ...$

$- (2*\exp(-Z - Y.*Z))/Z^2 + (2*S)/(\exp(2*Z)*Z^2) + (2*S). / (\exp(2.*Y.*Z)*Z^2) - (4*\exp(-Z - Y.*Z)*S)/Z^2 + S^2/(\exp(2*Z)*Z^2) + S^2. / (\exp(2.*Y.*Z)*Z^2) ...$

$- (2*\exp(-Z - Y.*Z)*S^2)/Z^2 + 2/(\exp(Z)*Z) - 2./(\exp(Y.*Z)*Z) + (2*S)/(\exp(Z)*Z) - (2*S). / (\exp(Y.*Z)*Z) - (2.*Y)/(\exp(Z)*Z) + (2.*Y)/(\exp(Y.*Z)*Z) ...$

$- (2*S.*Y)/(\exp(Z)*Z) + (2*S.*Y)/(\exp(Y.*Z)*Z) - Z/\exp(Z) - (S*Z)/\exp(Z) + (Y.*Z)/\exp(Z) + (S.*Y.*Z)/\exp(Z) + (Y.^2*Z)/\exp(Z) + (S.*Y.^2*Z)/\exp(Z) - (Y.^3*Z)/\exp(Z) ...$

$- (S.*Y.^3*Z)/\exp(Z) + Z^2/(4*\exp(2*Z)) + (S*Z^2)/(2*\exp(2*Z)) + (S^2*Z^2)/(4*\exp(2*Z)) - (Y.^2*Z^2)/(2*\exp(2*Z)) - (S.*Y.^2*Z^2)/\exp(2*Z) ...$

$- (S^2.*Y.^2*Z^2)/(2*\exp(2*Z)) + (Y.^4*Z^2)/(4*\exp(2*Z)) + (S.*Y.^4*Z^2)/(2*\exp(2*Z)) + (S^2.*Y.^4*Z^2)/(4*\exp(2*Z)) - (7*S*(S_v1))/(2*\exp(3*Z)) ...$

$+ (2*S*(S_v1))/\exp(2*Z) + (S*(S_v1))/\exp(Z) - (\exp(-Z - 2.*Y.*Z)*S*(S_v1))/2 - (5*S^2*(S_v1))/\exp(3*Z) + (2*S^2*(S_v1))/\exp(2*Z) - (S^2*(S_v1))/(2*\exp(Z)) ...$

$- (\exp(-Z - 2.*Y.*Z)*S^2*(S_v1))/2 - (2*S.*Y.(S_v1))/\exp(2*Z) - (3*S.*Y.(S_v1))/\exp(Z) + (3*S^2.*Y.(S_v1))/(2*\exp(3*Z)) - (2*S^2.*Y.(S_v1))/\exp(2*Z) ...$

$+ (S^2.*Y.(S_v1))/(2*\exp(Z)) + (13*S.*Y.^2*(S_v1))/(2*\exp(3*Z)) - (4*S.*Y.^2*(S_v1))/\exp(2*Z) + (3*S.*Y.^2*(S_v1))/\exp(Z) + (\exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1))/2 - (3*S.*Y.^3*(S_v1))/\exp(3*Z) ...$

$+ (5*S^2.*Y.^2*(S_v1))/\exp(3*Z) - (2*S^2.*Y.^2*(S_v1))/\exp(2*Z) + (S^2.*Y.^2*(S_v1))/(2*\exp(Z)) + (\exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1))/2 - (3*S.*Y.^3*(S_v1))/\exp(3*Z) ...$

$+ (4*S.*Y.^3*(S_v1))/\exp(2*Z) - (S.*Y.^3*(S_v1))/\exp(Z) - (3*S^2.*Y.^3*(S_v1))/(2*\exp(3*Z)) + (2*S^2.*Y.^3*(S_v1))/\exp(2*Z) - (S^2.*Y.^3*(S_v1))/(2*\exp(Z)) ...$

$+ (3*S*(S_v1))/(\exp(4*Z)*Z^3) - (4*S*(S_v1))/(\exp(3*Z)*Z^3) + (S*(S_v1))/(\exp(2*Z)*Z^3) + (S*(S_v1))./(\exp(2.*Y.*Z)*Z^3) + (3*\exp(-2*Z - 2.*Y.*Z)*S*(S_v1))/Z^3 ...$

$- (4*\exp(-Z - 2.*Y.*Z)*S*(S_v1))/Z^3 - (6*\exp(-3*Z - Y.*Z)*S*(S_v1))/Z^3 + (8*\exp(-2*Z - Y.*Z)*S*(S_v1))/Z^3 - (2*\exp(-Z - Y.*Z)*S*(S_v1))/Z^3 ...$

$$\begin{aligned}
& + (3*S^2*(S_v1))/(exp(4*Z)*Z^3) - (4*S^2*(S_v1))/(exp(3*Z)*Z^3) + (S^2*(S_v1))/(exp(2*Z)*Z^3) + \\
& (S^2*(S_v1))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v1))/Z^3 ... \\
& - (4*exp(-Z - 2.*Y.*Z)*S^2*(S_v1))/Z^3 - (6*exp(-3*Z - Y.*Z)*S^2*(S_v1))/Z^3 + (8*exp(-2*Z - \\
& Y.*Z)*S^2*(S_v1))/Z^3 - (2*exp(-Z - Y.*Z)*S^2*(S_v1))/Z^3 ... \\
& + (11*S*(S_v1))/(exp(3*Z)*Z^2) - (8*S*(S_v1))/(exp(2*Z)*Z^2) + (2*S*(S_v1))/(exp(Z)*Z^2) - \\
& (S*(S_v1))./(exp(3.*Y.*Z)*Z^2) - (2*S*(S_v1))./(exp(Y.*Z)*Z^2) ... \\
& - (exp(-Z - 2.*Y.*Z)*S*(S_v1))/Z^2 - (9*exp(-2*Z - Y.*Z)*S*(S_v1))/Z^2 + (8*exp(-Z - \\
& Y.*Z)*S*(S_v1))/Z^2 + (8*S^2*(S_v1))/(exp(3*Z)*Z^2); ... \\
& - (4*S^2*(S_v1))/(exp(2*Z)*Z^2) + (S^2*(S_v1))/(exp(Z)*Z^2) - (S^2*(S_v1))./(exp(3.*Y.*Z)*Z^2) - \\
& (S^2*(S_v1))./(exp(Y.*Z)*Z^2) - (exp(-Z - 2.*Y.*Z)*S^2*(S_v1))/Z^2 ... \\
& - (6*exp(-2*Z - Y.*Z)*S^2*(S_v1))/Z^2 + (4*exp(-Z - Y.*Z)*S^2*(S_v1))/Z^2 - \\
& (6*S.*Y.(S_v1))/(exp(3*Z)*Z^2) + (8*S.*Y.(S_v1))/(exp(2*Z)*Z^2) ... \\
& - (2*S.*Y.(S_v1))/(exp(Z)*Z^2) + (2*S.*Y.(S_v1))/(exp(Y.*Z)*Z^2) + (6*exp(-2*Z - \\
& Y.*Z)*S.*Y.(S_v1))/Z^2 - (8*exp(-Z - Y.*Z)*S.*Y.(S_v1))/Z^2 ... \\
& - (3*S^2.*Y.(S_v1))/(exp(3*Z)*Z^2) + (4*S^2.*Y.(S_v1))/(exp(2*Z)*Z^2) - \\
& (S^2.*Y.(S_v1))/(exp(Z)*Z^2) + (S^2.*Y.(S_v1))/(exp(Y.*Z)*Z^2) ... \\
& + (3*exp(-2*Z - Y.*Z)*S^2.*Y.(S_v1))/Z^2 - (4*exp(-Z - Y.*Z)*S^2.*Y.(S_v1))/Z^2 + (S*(S_v1))/Z \\
& + (2*S*(S_v1))/(exp(3*Z)*Z) + (9*S*(S_v1))/(exp(2*Z)*Z) ... \\
& - (4*S*(S_v1))/(exp(Z)*Z) + (S*(S_v1))./(exp(2.*Y.*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S*(S_v1))/Z \\
& + (exp(-Z - Y.*Z)*S*(S_v1))/Z + (2*S^2*(S_v1))/(exp(3*Z)*Z) ... \\
& + (S^2*(S_v1))/(exp(2*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S^2*(S_v1))/Z - (exp(-Z - Y.*Z)*S^2*(S_v1))/Z \\
& - (2*S.*Y.(S_v1))/Z - (13*S.*Y.(S_v1))/(exp(2*Z)*Z) ... \\
& + (8*S.*Y.(S_v1))/(exp(Z)*Z) - (S.*Y.(S_v1))./(exp(2.*Y.*Z)*Z) - \\
& (2*S^2.*Y.(S_v1))/(exp(2*Z)*Z) + (2*exp(-Z - Y.*Z)*S^2.*Y.(S_v1))/Z + (S.*Y.^2*(S_v1))/Z ... \\
& + (3*S.*Y.^2*(S_v1))/(exp(4*Z)*Z) - (4*S.*Y.^2*(S_v1))/(exp(3*Z)*Z) + \\
& (4*S.*Y.^2*(S_v1))/(exp(2*Z)*Z) - (4*S.*Y.^2*(S_v1))/(exp(Z)*Z) ... \\
& - (3*exp(-3*Z - Y.*Z)*S.*Y.^2*(S_v1))/Z + (4*exp(-2*Z - Y.*Z)*S.*Y.^2*(S_v1))/Z - (exp(-Z - \\
& Y.*Z)*S.*Y.^2*(S_v1))/Z + (3*S^2.*Y.^2*(S_v1))/(exp(4*Z)*Z) ... \\
& - (4*S^2.*Y.^2*(S_v1))/(exp(3*Z)*Z) + (S^2.*Y.^2*(S_v1))/(exp(2*Z)*Z) - (3*exp(-3*Z - \\
& Y.*Z)*S^2.*Y.^2*(S_v1))/Z + (4*exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v1))/Z ... \\
& - (exp(-Z - Y.*Z)*S^2.*Y.^2*(S_v1))/Z - (3*S^2.*Y.^2*(S_v1))/(4*exp(4*Z)) - (7*S^2.*Y.^2*(S_v1))/(4*exp(2*Z)) \\
& - (3*S^2.*Y.^2*(S_v1))/(4*exp(4*Z)) - (3*S^2.*Z*(S_v1))/(4*exp(2*Z)) ... \\
& + (2*S.*Y.*Z*(S_v1))/(exp(2*Z) + (S^2.*Y.*Z*(S_v1))/(exp(2*Z) + (S.*Y.^2*Z*(S_v1))/exp(3*Z) + \\
& (3*S.*Y.^2*Z*(S_v1))/(2*exp(2*Z)) + (S^2.*Y.^2*Z*(S_v1))/(exp(3*Z) ... \\
& + (S^2.*Y.^2*Z*(S_v1))/(2*exp(2*Z)) - (2*S.*Y.^2*Z*(S_v1))/(exp(2*Z) - \\
& (S^2.*Y.^3*Z*(S_v1))/(exp(2*Z) + (3*S.*Y.^4*Z*(S_v1))/(4*exp(4*Z)) - (S.*Y.^4*Z*(S_v1))/exp(3*Z) \\
& ... \\
& + (S.*Y.^4*Z*(S_v1))/(4*exp(2*Z)) + (3*S^2.*Y.^4*Z*(S_v1))/(4*exp(4*Z)) - \\
& (S^2.*Y.^4*Z*(S_v1))/exp(3*Z) + (S^2.*Y.^4*Z*(S_v1))/(4*exp(2*Z)) + (S^2.*Z^2*(S_v1))/(2*exp(3*Z)) \\
& ... \\
& + (S^2.*Z^2*(S_v1))/(2*exp(3*Z)) - (S.*Y.^2*Z^2*(S_v1))/exp(3*Z) - \\
& (S^2.*Y.^2*Z^2*(S_v1))/exp(3*Z) + (S.*Y.^4*Z^2*(S_v1))/(2*exp(3*Z)) ... \\
& + (S^2.*Y.^4*Z^2*(S_v1))/(2*exp(3*Z)) + (9*S^2*(S_v1)^2)/(16*exp(6*Z)) - \\
& (23*S^2*(S_v1)^2)/(8*exp(4*Z)) + (2*S^2*(S_v1)^2)/exp(3*Z) + (S^2*(S_v1)^2)/(16*exp(2*Z)) ... \\
& - (exp(-2*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/2 - exp(-3*Z - Y.*Z)*S^2*(S_v1)^2 - \\
& (2*S^2.*Y.(S_v1)^2)/(exp(3*Z) - (S^2.*Y.(S_v1)^2)/exp(2*Z) + (9*S^2.*Y.^2*(S_v1)^2)/(8*exp(6*Z))) \\
& ... \\
& - (3*S^2.*Y.^2*(S_v1)^2)/(2*exp(5*Z)) + (11*S^2.*Y.^2*(S_v1)^2)/(2*exp(4*Z)) - \\
& (7*S^2.*Y.^2*(S_v1)^2)/(2*exp(3*Z)) + (15*S^2.*Y.^2*(S_v1)^2)/(8*exp(2*Z)) ... \\
& + (exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/2 + exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v1)^2 - \\
& (3*S^2.*Y.^3*(S_v1)^2)/(exp(4*Z) + (4*S^2.*Y.^3*(S_v1)^2)/exp(3*Z) ... \\
& - (S^2.*Y.^3*(S_v1)^2)/(exp(2*Z)) + (9*S^2.*Y.^4*(S_v1)^2)/(16*exp(6*Z)) - \\
& (3*S^2.*Y.^4*(S_v1)^2)/(2*exp(5*Z)) + (11*S^2.*Y.^4*(S_v1)^2)/(8*exp(4*Z)) ... \\
& - (S^2.*Y.^4*(S_v1)^2)/(2*exp(3*Z)) + (S^2.*Y.^4*(S_v1)^2)/(16*exp(2*Z)) + \\
& (9*S^2*(S_v1)^2)/(4*exp(6*Z)*Z^4) - (6*S^2*(S_v1)^2)/(exp(5*Z)*Z^4) ...
\end{aligned}$$

$$\begin{aligned}
& + \frac{(11*S^2*(S_v1)^2)/(2*exp(4*Z)*Z^4)}{(S^2*(S_v1)^2)/(4*exp(2*Z)*Z^4) + (S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^4)} - \frac{(2*S^2*(S_v1)^2)/(exp(3*Z)*Z^4)}{(2*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^4)} + \\
& + \frac{(9*exp(-4*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*Z^4)}{(9*exp(-4*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^4)} - \frac{(6*exp(-3*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/Z^4}{(6*exp(-3*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^4)} + \\
& + \frac{(11*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(2*Z^4)}{(11*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^4)} ... \\
& - \frac{(2*exp(-Z - 2.*Y.*Z)*S^2*(S_v1)^2)/Z^4}{(2*exp(-Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^4)} - \frac{(9*exp(-5*Z - Y.*Z)*S^2*(S_v1)^2)/(2*Z^4)}{(9*exp(-5*Z - Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^4)} + \\
& + \frac{(12*exp(-4*Z - Y.*Z)*S^2*(S_v1)^2)/(2*Z^4)}{(12*exp(-4*Z - Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^4)} ... \\
& + \frac{(27*S^2*(S_v1)^2)/(2*exp(3*Z)*Z^3)}{(27*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} - \frac{(4*S^2*(S_v1)^2)/(exp(2*Z)*Z^3)}{(4*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} + \\
& + \frac{(S^2*(S_v1)^2)/(2*exp(Z)*Z^3)}{(S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} - \frac{(S^2*(S_v1)^2)/(2*exp(3.*Y.*Z)*Z^3)}{(S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} ... \\
& - \frac{(S^2*(S_v1)^2)/(2*exp(Y.*Z)*Z^3)}{(S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} - \frac{(3*exp(-2*Z - 3.*Y.*Z)*S^2*(S_v1)^2)/(2*Z^3)}{(3*exp(-2*Z - 3.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} + \\
& + \frac{(2*exp(-Z - 3.*Y.*Z)*S^2*(S_v1)^2)/(2*Z^3)}{(2*exp(-Z - 3.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} - \frac{(exp(-Z - 3.*Y.*Z)*S^2*(S_v1)^2)/(2*Z^3)}{(exp(-Z - 3.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} ... \\
& + \frac{(2*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(2*Z^3)}{(2*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} - \frac{(exp(-Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(2*Z^3)}{(exp(-Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} - \frac{(9*exp(-4*Z - Y.*Z)*S^2*(S_v1)^2)/(2*Z^3)}{(9*exp(-4*Z - Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} ... \\
& - \frac{(11*S^2.*Y.(S_v1)^2)/(exp(3*Z)*Z^3)}{(11*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} + \frac{(4*S^2.*Y.(S_v1)^2)/(exp(2*Z)*Z^3)}{(4*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} - \\
& + \frac{(S^2.*Y.(S_v1)^2)/(2*exp(Z)*Z^3)}{(S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} + \frac{(S^2.*Y.(S_v1)^2)/(2*exp(Y.*Z)*Z^3)}{(S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} ... \\
& + \frac{(9*exp(-4*Z - Y.*Z)*S^2.*Y.(S_v1)^2)/(2*Z^3)}{(9*exp(-4*Z - Y.*Z)*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} - \frac{(12*exp(-3*Z - Y.*Z)*S^2.*Y.(S_v1)^2)/(2*Z^3)}{(12*exp(-3*Z - Y.*Z)*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} + \\
& + \frac{(11*exp(-2*Z - Y.*Z)*S^2.*Y.(S_v1)^2)/(2*Z^3)}{(11*exp(-2*Z - Y.*Z)*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} ... \\
& - \frac{(4*exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v1)^2)/(2*Z^3)}{(4*exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^3)} + \frac{(S^2*(S_v1)^2)/(4*Z^2)}{(S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \\
& + \frac{(9*S^2*(S_v1)^2)/(4*exp(6*Z)*Z^2)}{(9*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} - \frac{(3*S^2*(S_v1)^2)/(exp(5*Z)*Z^2)}{(3*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \\
& + \frac{(19*S^2*(S_v1)^2)/(exp(4*Z)*Z^2)}{(19*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} ... \\
& - \frac{(19*S^2*(S_v1)^2)/(exp(3*Z)*Z^2)}{(19*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \frac{(35*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)}{(35*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} - \\
& + \frac{(2*S^2*(S_v1)^2)/(exp(Z)*Z^2)}{(2*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \frac{(S^2*(S_v1)^2)/(4*exp(4*Y.*Z)*Z^2)}{(S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} ... \\
& + \frac{(S^2*(S_v1)^2)/(2*exp(2.*Y.*Z)*Z^2)}{(S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \frac{(exp(-Z - 3.*Y.*Z)*S^2*(S_v1)^2)/(2*Z^2)}{(exp(-Z - 3.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \frac{(5*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(2*Z^2)}{(5*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} ... \\
& - \frac{(9*exp(-5*Z - Y.*Z)*S^2*(S_v1)^2)/(4*Z^2)}{(9*exp(-5*Z - Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \frac{(3*exp(-4*Z - Y.*Z)*S^2*(S_v1)^2)/(2*Z^2)}{(3*exp(-4*Z - Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \frac{(5*exp(-3*Z - Y.*Z)*S^2*(S_v1)^2)/(2*Z^2)}{(5*exp(-3*Z - Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} ... \\
& + \frac{(exp(-Z - 3.*Y.*Z)*S^2*(S_v1)^2)/(4*Z^2)}{(exp(-Z - 3.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} - \frac{(S^2.*Y.(S_v1)^2)/(2*Z^2)}{(S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} - \\
& + \frac{(15*S^2.*Y.(S_v1)^2)/(exp(4*Z)*Z^2)}{(15*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \frac{(26*S^2.*Y.(S_v1)^2)/(exp(3*Z)*Z^2)}{(26*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} ... \\
& - \frac{(29*S^2.*Y.(S_v1)^2)/(2*exp(2*Z)*Z^2)}{(29*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \frac{(4*S^2.*Y.(S_v1)^2)/(exp(Z)*Z^2)}{(4*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} - \\
& + \frac{(S^2.*Y.(S_v1)^2)/(2*exp(2.*Y.*Z)*Z^2)}{(S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} - \frac{(3*exp(-2*Z - 2.*Y.*Z)*S^2.*Y.(S_v1)^2)/(2*Z^2)}{(3*exp(-2*Z - 2.*Y.*Z)*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} ... \\
& + \frac{(2*exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v1)^2)/(2*Z^2)}{(2*exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \frac{(S^2.*Y.^2*(S_v1)^2)/(4*Z^2)}{(S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \\
& + \frac{(9*S^2.*Y.^2*(S_v1)^2)/(4*exp(6*Z)*Z^2)}{(9*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} - \frac{(6*S^2.*Y.^2*(S_v1)^2)/(exp(5*Z)*Z^2)}{(6*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} ... \\
& + \frac{(31*S^2.*Y.^2*(S_v1)^2)/(4*exp(4*Z)*Z^2)}{(31*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} - \frac{(8*S^2.*Y.^2*(S_v1)^2)/(exp(3*Z)*Z^2)}{(8*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \\
& + \frac{(23*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Z)*Z^2)}{(23*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} - \frac{(2*S^2.*Y.^2*(S_v1)^2)/(exp(Z)*Z^2)}{(2*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} ... \\
& - \frac{(9*exp(-5*Z - Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*Z^2)}{(9*exp(-5*Z - Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \frac{(6*exp(-4*Z - Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(2*Z^2)}{(6*exp(-4*Z - Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} ... \\
& - \frac{(11*exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(2*Z^2)}{(11*exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} ... \\
& + \frac{(2*exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(2*Z^2)}{(2*exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} - \frac{(exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(2*Z^2)}{(exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z^2)} + \\
& + \frac{(9*S^2*(S_v1)^2)/(2*exp(5*Z)*Z)}{(9*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} - \frac{(S^2*(S_v1)^2)/(exp(4*Z)*Z)}{(S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} ... \\
& + \frac{(25*S^2*(S_v1)^2)/(4*exp(3*Z)*Z)}{(25*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} - \frac{(3*S^2*(S_v1)^2)/(exp(2*Z)*Z)}{(3*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} + \\
& + \frac{(3*S^2*(S_v1)^2)/(4*exp(Z)*Z)}{(3*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} + \frac{(3*exp(-3*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*Z)}{(3*exp(-3*Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} ... \\
& + \frac{(3*exp(-Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*Z)}{(3*exp(-Z - 2.*Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} + \frac{(3*exp(-4*Z - Y.*Z)*S^2*(S_v1)^2)/Z}{(3*exp(-4*Z - Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} - \frac{(2*exp(-3*Z - Y.*Z)*S^2*(S_v1)^2)/Z}{(2*exp(-3*Z - Y.*Z)*S^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} ... \\
& - \frac{(9*S^2.*Y.(S_v1)^2)/(4*exp(5*Z)*Z)}{(9*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} + \frac{(3*S^2.*Y.(S_v1)^2)/(exp(4*Z)*Z)}{(3*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} - \\
& + \frac{(11*S^2.*Y.(S_v1)^2)/(exp(3*Z)*Z)}{(11*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} + \frac{(7*S^2.*Y.(S_v1)^2)/(exp(2*Z)*Z)}{(7*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} ... \\
& - \frac{(7*S^2.*Y.(S_v1)^2)/(4*exp(Z)*Z)}{(7*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} - \frac{(exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v1)^2)/(2*Z)}{(exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} - \frac{(2*exp(-2*Z - Y.*Z)*S^2.*Y.(S_v1)^2)/(2*Z)}{(2*exp(-2*Z - Y.*Z)*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} ... \\
& - \frac{(13*S^2.*Y.(S_v1)^2)/(exp(4*Z)*Z)}{(13*S^2.*Y.(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} + \frac{(41*S^2.*Y.^2*(S_v1)^2)/(4*exp(3*Z)*Z)}{(41*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} - \\
& + \frac{(6*S^2.*Y.^2*(S_v1)^2)/(exp(2*Z)*Z)}{(6*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} + \frac{(5*S^2.*Y.^2*(S_v1)^2)/(exp(2*Y.*Z)*Z)}{(5*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} ... \\
& + \frac{(3*exp(-3*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*Z)}{(3*exp(-3*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} - \frac{(exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*Z)}{(exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} + \\
& + \frac{(3*exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*Z)}{(3*exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} - \frac{(exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*Z)}{(exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} ... \\
& - \frac{(9*S^2.*Y.^3*(S_v1)^2)/(4*exp(5*Z)*Z)}{(9*S^2.*Y.^3*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} + \frac{(6*S^2.*Y.^3*(S_v1)^2)/(exp(4*Z)*Z)}{(6*S^2.*Y.^3*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} - \\
& + \frac{(11*S^2.*Y.^3*(S_v1)^2)/(2*exp(3*Z)*Z)}{(11*S^2.*Y.^3*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} + \frac{(2*S^2.*Y.^3*(S_v1)^2)/(exp(2*Z)*Z)}{(2*S^2.*Y.^3*(S_v1)^2)/(4*exp(2*Y.*Z)*Z)} ...
\end{aligned}$$

$$\begin{aligned}
& - \frac{(S^2.*Y.^3*(S_v1)^2)/(4*\exp(Z)*Z)}{(3*S^2*Z*(S_v1)^2)/(4*\exp(3*Z))} + \frac{(3*S^2*Z*(S_v1)^2)/(4*\exp(5*Z))}{(S^2.*Y.^2*Z*(S_v1)^2)/\exp(3*Z)} \\
& (S^2.*Y.^2*Z*(S_v1)^2)/\exp(4*Z) ... \\
& + \frac{(S^2.*Y.^2*Z*(S_v1)^2)/(2*\exp(3*Z))}{(3*S^2.*Y.^4*Z*(S_v1)^2)/(4*\exp(5*Z))} - \frac{(S^2.*Y.^4*Z*(S_v1)^2)/\exp(4*Z) ...}{(S^2.*Y.^4*Z*(S_v1)^2)/(4*\exp(3*Z))} \\
& + \frac{(S^2.*Y.^4*Z*(S_v1)^2)/(4*\exp(4*Z))}{(S^2.*Y.^2*Z^2*(S_v1)^2)/(2*\exp(4*Z))} + \frac{(S^2.*Y.^4*Z^2*(S_v1)^2)/(4*\exp(4*Z))}{(S^2.*Y.^2*Z^2*(S_v1)^2)/(4*\exp(4*Z))}; 
\end{aligned}$$

```

Ns1=Nf+Nc+Ny1;
Phi1=Nf./[Nc+Ny1];
Be1=1./[1+Phi1];
Gf1=Nf./Ns1;
Gh1=[Nc+Ny1]./Ns1;
Nh1=Nc+Ny1;

```

$$\begin{aligned}
S_v2 &= 2; \\
Ny2 &= 1 - \exp(-2*Z) + \exp(-Z - Y.*Z) - (2*S)/\exp(2*Z) + 2*\exp(-Z - Y.*Z)*S - S^2/\exp(2*Z) + \exp(-Z - Y.*Z)*S^2 - 2.*Y + Y.^2 + Y.^2/\exp(2*Z) - \exp(-Z - Y.*Z).*Y.^2 ... \\
& + (2*S.*Y.^2)/\exp(2*Z) - 2*\exp(-Z - Y.*Z)*S.*Y.^2 + (S^2.*Y.^2)/\exp(2*Z) - \exp(-Z - Y.*Z)*S^2.*Y.^2 + 1/(exp(2*Z)*Z^2) + 1. / (exp(2.*Y.*Z)*Z^2) ... \\
& - (2*\exp(-Z - Y.*Z))/Z^2 + (2*S)/(\exp(2*Z)*Z^2) + (2*S)./(\exp(2.*Y.*Z)*Z^2) - (4*\exp(-Z - Y.*Z)*S)/Z^2 + S^2/(\exp(2*Z)*Z^2) + S^2. / (\exp(2.*Y.*Z)*Z^2) ... \\
& - (2*\exp(-Z - Y.*Z)*S^2)/Z^2 + 2/(\exp(Z)*Z) - 2. / (\exp(Y.*Z)*Z) + (2*S)/(\exp(Z)*Z) - (2*S)./(\exp(Y.*Z)*Z) - (2.*Y)/(\exp(Z)*Z) + (2.*Y)/(\exp(Y.*Z)*Z) ... \\
& - (2*S.*Y)/(\exp(Z)*Z) + (2*S.*Y)/(\exp(Y.*Z)*Z) - Z/\exp(Z) - (S*Z)/\exp(Z) + (Y.*Z)/\exp(Z) + (S.*Y.*Z)/\exp(Z) + (Y.^2*Z)/\exp(Z) + (S.*Y.^2*Z)/\exp(Z) - (Y.^3*Z)/\exp(Z) ... \\
& - (S.*Y.^3*Z)/\exp(Z) + Z^2/(4*\exp(2*Z)) + (S*Z^2)/(2*\exp(2*Z)) + (S^2*Z^2)/(4*\exp(2*Z)) - (Y.^2*Z^2)/(2*\exp(2*Z)) - (S.*Y.^2*Z^2)/\exp(2*Z) ... \\
& - (S^2.*Y.^2*Z^2)/(2*\exp(2*Z)) + (Y.^4*Z^2)/(4*\exp(2*Z)) + (S.*Y.^4*Z^2)/(2*\exp(2*Z)) + (S^2.*Y.^4*Z^2)/(4*\exp(2*Z)) - (7*S*(S_v2))/(2*\exp(3*Z)) ... \\
& + (2*S*(S_v2))/\exp(2*Z) + (S*(S_v2))/\exp(Z) - (\exp(-Z - 2.*Y.*Z)*S*(S_v2))/2 - (5*S^2*(S_v2))/\exp(3*Z) + (2*S^2*(S_v2))/\exp(2*Z) - (S^2*(S_v2))/(2*\exp(Z)) ... \\
& - (\exp(-Z - 2.*Y.*Z)*S^2*(S_v2))/2 - (2*S.*Y.*S*(S_v2))/\exp(2*Z) - (3*S.*Y.*S*(S_v2))/\exp(Z) + (3*S^2.*Y.*S*(S_v2))/(2*\exp(3*Z)) - (2*S^2.*Y.*S*(S_v2))/\exp(2*Z) ... \\
& + (S^2.*Y.*S*(S_v2))/(2*\exp(Z)) + (13*S.*Y.^2*(S_v2))/(2*\exp(3*Z)) - (4*S.*Y.^2*(S_v2))/\exp(2*Z) + (3*S.*Y.^2*(S_v2))/\exp(Z) + (\exp(-Z - 2.*Y.*Z)*S.^2.*Y.^2*(S_v2))/2 ... \\
& + (5*S^2.*Y.^2*(S_v2))/\exp(3*Z) - (2*S^2.*Y.^2*(S_v2))/\exp(2*Z) + (S^2.*Y.^2*(S_v2))/(2*\exp(Z)) + (\exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v2))/2 - (3*S.*Y.^3*(S_v2))/\exp(3*Z) ... \\
& + (4*S.*Y.^3*(S_v2))/\exp(2*Z) - (S.*Y.^3*(S_v2))/\exp(Z) - (3*S^2.*Y.^3*(S_v2))/(2*\exp(3*Z)) + (2*S^2.*Y.^3*(S_v2))/\exp(2*Z) - (S^2.*Y.^3*(S_v2))/(2*\exp(Z)) ... \\
& + (3*S*(S_v2))/\exp(4*Z)*Z^3) - (4*S*(S_v2))/\exp(3*Z)*Z^3) + (S*(S_v2))/\exp(2*Z)*Z^3) + (S*(S_v2))./(\exp(2.*Y.*Z)*Z^3) + (3*\exp(-2*Z - 2.*Y.*Z)*S*(S_v2))/Z^3 ... \\
& - (4*\exp(-Z - 2.*Y.*Z)*S*(S_v2))/Z^3 - (6*\exp(-3*Z - Y.*Z)*S*(S_v2))/Z^3 + (8*\exp(-2*Z - Y.*Z)*S*(S_v2))/Z^3 - (2*\exp(-Z - Y.*Z)*S*(S_v2))/Z^3 ... \\
& + (3*S^2*(S_v2))/\exp(4*Z)*Z^3) - (4*S^2*(S_v2))/\exp(3*Z)*Z^3) + (S^2*(S_v2))/\exp(2*Z)*Z^3) + (S^2*(S_v2))./(\exp(2.*Y.*Z)*Z^3) + (3*\exp(-2*Z - 2.*Y.*Z)*S^2*(S_v2))/Z^3 ... \\
& - (4*\exp(-Z - 2.*Y.*Z)*S^2*(S_v2))/Z^3 - (6*\exp(-3*Z - Y.*Z)*S^2*(S_v2))/Z^3 + (8*\exp(-2*Z - Y.*Z)*S^2*(S_v2))/Z^3 - (2*\exp(-Z - Y.*Z)*S^2*(S_v2))/Z^3 ... \\
& + (11*S*(S_v2))/\exp(3*Z)*Z^2) - (8*S*(S_v2))/\exp(2*Z)*Z^2) + (2*S*(S_v2))/\exp(Z)*Z^2) - (S*(S_v2))./(\exp(3.*Y.*Z)*Z^2) - (2*S*(S_v2))./(\exp(Y.*Z)*Z^2) ... \\
& - (\exp(-Z - 2.*Y.*Z)*S*(S_v2))/Z^2 - (9*\exp(-2*Z - Y.*Z)*S*(S_v2))/Z^2 + (8*\exp(-Z - Y.*Z)*S*(S_v2))/Z^2 + (8*\exp(-Z - Y.*Z)*S*(S_v2))/Z^2 + (8*S^2*(S_v2))/\exp(3*Z)*Z^2); ... \\
& - (4*S^2*(S_v2))/\exp(2*Z)*Z^2) + (S^2*(S_v2))/\exp(Z)*Z^2) - (S^2*(S_v2))./(\exp(3.*Y.*Z)*Z^2) - (S^2*(S_v2))./(\exp(Y.*Z)*Z^2) - (\exp(-Z - 2.*Y.*Z)*S^2*(S_v2))/Z^2 ...
\end{aligned}$$

$$\begin{aligned}
& - \frac{(6*\exp(-2*Z) - Y.*Z)*S^2*(S_v2))/Z^2}{(6*S.*Y.(S_v2))/(exp(3*Z)*Z^2) + (8*S.*Y.(S_v2))/(exp(2*Z)*Z^2)} ... \\
& - \frac{(2*S.*Y.(S_v2))/(exp(Z)*Z^2) + (2*S.*Y.(S_v2))/(exp(Y.*Z)*Z^2)}{(Y.*Z)*S.*Y.(S_v2))/Z^2 - (8*\exp(-Z - Y.*Z)*S.*Y.(S_v2))/Z^2} ... \\
& - \frac{(3*S^2.*Y.(S_v2))/(exp(3*Z)*Z^2)}{(S^2.*Y.(S_v2))/(exp(Z)*Z^2) + (S^2.*Y.(S_v2))/(exp(Y.*Z)*Z^2)} ... \\
& + \frac{(4*S^2.*Y.(S_v2))/(exp(2*Z)*Z^2)}{(3*\exp(-2*Z - Y.*Z)*S^2.*Y.(S_v2))/Z^2 - (4*\exp(-Z - Y.*Z)*S^2.*Y.(S_v2))/Z^2 + (S*(S_v2))/Z} \\
& + \frac{(2*S*(S_v2))/(exp(3*Z)*Z) + (9*S*(S_v2))/(exp(2*Z)*Z)}{...} \\
& - \frac{(4*S*(S_v2))/(exp(Z)*Z) + (S*(S_v2))./(exp(2.*Y.*Z)*Z)}{(2*\exp(-2*Z - Y.*Z)*S*(S_v2))/Z + (2*S^2*(S_v2))/(exp(3*Z)*Z)} ... \\
& + \frac{(S^2*(S_v2))/(exp(2*Z)*Z) - (2*\exp(-2*Z - Y.*Z)*S^2*(S_v2))/Z - (\exp(-Z - Y.*Z)*S^2*(S_v2))/Z - (2*S.*Y.(S_v2))/Z - (13*S.*Y.(S_v2))/(exp(2*Z)*Z)} ... \\
& + \frac{(8*S.*Y.(S_v2))/(exp(Z)*Z)}{(S.*Y.(S_v2))./(exp(2.*Y.*Z)*Z)} ... \\
& (2*S^2.*Y.(S_v2))/(exp(2*Z)*Z) + (2*\exp(-Z - Y.*Z)*S^2.*Y.(S_v2))/Z + (S.*Y.^2*(S_v2))/Z ... \\
& + \frac{(3*S.*Y.^2*(S_v2))/(exp(4*Z)*Z)}{(4*S.*Y.^2*(S_v2))/(exp(2*Z)*Z) - (4*S.*Y.^2*(S_v2))/(exp(Z)*Z)} ... \\
& - \frac{(3*\exp(-3*Z - Y.*Z)*S.*Y.^2*(S_v2))/Z + (4*\exp(-2*Z - Y.*Z)*S.*Y.^2*(S_v2))/Z - (\exp(-Z - Y.*Z)*S.*Y.^2*(S_v2))/Z + (3*S^2.*Y.^2*(S_v2))/(exp(4*Z)*Z)} ... \\
& - \frac{(4*S^2.*Y.^2*(S_v2))/(exp(3*Z)*Z) + (S^2.*Y.^2*(S_v2))/(exp(2*Z)*Z) - (3*\exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v2))/Z + (4*\exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v2))/Z ...} \\
& - \frac{(\exp(-Z - Y.*Z)*S^2.*Y.^2*(S_v2))/Z - (3*S^2*(S_v2))/(4*\exp(4*Z)) - (7*S^2*(S_v2))/(4*\exp(2*Z))}{(3*S^2*Z*(S_v2))/(4*\exp(4*Z)) - (3*S^2*Z*(S_v2))/(4*\exp(2*Z)) ...} \\
& + \frac{(2*S.*Y.^2*(S_v2))/(exp(2*Z) + (S^2.*Y.^2*(S_v2))/(exp(2*Z) + (S.*Y.^2*Z*(S_v2))/exp(3*Z) + (3*S.*Y.^2*Z*(S_v2))/(2*\exp(2*Z)) + (S^2.*Y.^2*Z*(S_v2))/(exp(3*Z) ...} \\
& + \frac{(S^2.*Y.^2*Z*(S_v2))/(2*\exp(2*Z)) - (2*S.*Y.^3*Z*(S_v2))/exp(2*Z) - (S^2.*Y.^3*Z*(S_v2))/exp(4*Z)}{(S^2.*Y.^3*Z*(S_v2))/exp(2*Z) + (3*S.*Y.^4*Z*(S_v2))/(4*\exp(4*Z)) - (S.*Y.^4*Z*(S_v2))/exp(3*Z) ...} \\
& ... \\
& + \frac{(S.*Y.^4*Z*(S_v2))/(4*\exp(2*Z)) + (3*S^2.*Y.^4*Z*(S_v2))/(4*\exp(4*Z))}{(S^2.*Y.^4*Z*(S_v2))/exp(3*Z) + (S^2.*Y.^4*Z*(S_v2))/(4*\exp(2*Z)) + (S^2*Z^2*(S_v2))/(2*\exp(3*Z)) ...} \\
& ... \\
& + \frac{(S^2*Z^2*(S_v2))/(2*\exp(3*Z)) - (S.*Y.^2*Z^2*(S_v2))/exp(3*Z)}{(S^2.*Y.^2*Z^2*(S_v2))/exp(3*Z) + (S.*Y.^4*Z^2*(S_v2))/(2*\exp(3*Z)) ...} \\
& + \frac{(S^2.*Y.^4*Z^2*(S_v2))/(2*\exp(3*Z))}{(9*S^2*(S_v2)^2)/(16*\exp(6*Z))} ... \\
& (23*S^2*(S_v2)^2)/(8*\exp(4*Z)) + (2*S^2*(S_v2)^2)/exp(3*Z) + (S^2*(S_v2)^2)/(16*\exp(2*Z)) ... \\
& - \frac{(\exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v2)^2)/2 - \exp(-3*Z - Y.*Z)*S^2*(S_v2)^2}{(2*S^2.*Y.(S_v2)^2)/exp(3*Z) - (S^2.*Y.(S_v2)^2)/exp(2*Z) + (9*S^2.*Y.^2*(S_v2)^2)/(8*\exp(6*Z))} ... \\
& ... \\
& - \frac{(3*S^2.*Y.^2*(S_v2)^2)/(2*\exp(5*Z))}{(7*S^2.*Y.^2*(S_v2)^2)/(2*\exp(3*Z)) + (15*S^2.*Y.^2*(S_v2)^2)/(8*\exp(2*Z)) ...} \\
& + \frac{(\exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v2)^2)/2 + \exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v2)^2}{(3*S^2.*Y.^3*(S_v2)^2)/exp(4*Z) + (4*S^2.*Y.^3*(S_v2)^2)/exp(3*Z) ...} \\
& - \frac{(S^2.*Y.^3*(S_v2)^2)/exp(2*Z) + (9*S^2.*Y.^4*(S_v2)^2)/(16*\exp(6*Z))}{(3*S^2.*Y.^4*(S_v2)^2)/(2*\exp(5*Z)) + (11*S^2.*Y.^4*(S_v2)^2)/(8*\exp(4*Z)) ...} \\
& - \frac{(S^2.*Y.^4*(S_v2)^2)/(2*\exp(3*Z))}{(S^2.*Y.^4*(S_v2)^2)/(16*\exp(2*Z))} ... \\
& (9*S^2*(S_v2)^2)/(4*\exp(6*Z)*Z^4) - (6*S^2*(S_v2)^2)/(exp(5*Z)*Z^4) ... \\
& + \frac{(11*S^2*(S_v2)^2)/(2*\exp(4*Z)*Z^4)}{(S^2*(S_v2)^2)/(4*\exp(2*Z)*Z^4) + (S^2*(S_v2)^2)/(4*\exp(2.*Y.*Z)*Z^4) ...} \\
& + \frac{(9*\exp(-4*Z - 2.*Y.*Z)*S^2*(S_v2)^2)/(4*Z^4) - (6*\exp(-3*Z - 2.*Y.*Z)*S^2*(S_v2)^2)/Z^4 + (11*\exp(-2*Z - 2.*Y.*Z)*S^2*(S_v2)^2)/(2*Z^4) ...} \\
& - \frac{(2*\exp(-Z - 2.*Y.*Z)*S^2*(S_v2)^2)/Z^4 - (9*\exp(-5*Z - Y.*Z)*S^2*(S_v2)^2)/(2*Z^4) + (12*\exp(-4*Z - Y.*Z)*S^2*(S_v2)^2)/Z^4 - (11*\exp(-3*Z - Y.*Z)*S^2*(S_v2)^2)/Z^4 ...} \\
& + \frac{(4*\exp(-2*Z - Y.*Z)*S^2*(S_v2)^2)/Z^4 - (\exp(-Z - Y.*Z)*S^2*(S_v2)^2)/(2*Z^4)}{(12*S^2*(S_v2)^2)/(exp(5*Z)*Z^3) - (22*S^2*(S_v2)^2)/(exp(4*Z)*Z^3) ...} \\
& + \frac{(27*S^2*(S_v2)^2)/(2*\exp(3*Z)*Z^3) - (4*S^2*(S_v2)^2)/(exp(2*Z)*Z^3)}{(S^2*(S_v2)^2)/(2*\exp(Z)*Z^3) - (S^2*(S_v2)^2)./(2*\exp(3.*Y.*Z)*Z^3) ...}
\end{aligned}$$

$$\begin{aligned}
& - (S^2*(S_v2)^2)/(2*\exp(Y.*Z)*Z^3) - (3*\exp(-2*Z - 3.*Y.*Z)*S^2*(S_v2)^2)/(2*Z^3) + (2*\exp(-Z - 3.*Y.*Z)*S^2*(S_v2)^2)/Z^3 - (3*\exp(-3*Z - 2.*Y.*Z)*S^2*(S_v2)^2)/(2*Z^3) \dots \\
& + (2*\exp(-2*Z - 2.*Y.*Z)*S^2*(S_v2)^2)/Z^3 - (\exp(-Z - 2.*Y.*Z)*S^2*(S_v2)^2)/(2*Z^3) - (9*\exp(-4*Z - Y.*Z)*S^2*(S_v2)^2)/Z^3 + (18*\exp(-3*Z - Y.*Z)*S^2*(S_v2)^2)/Z^3 \dots \\
& - (25*\exp(-2*Z - Y.*Z)*S^2*(S_v2)^2)/(2*Z^3) + (4*\exp(-Z - Y.*Z)*S^2*(S_v2)^2)/Z^3 - (9*S^2.*Y.(S_v2)^2)/(2*\exp(5*Z)*Z^3) + (12*S^2.*Y.(S_v2)^2)/(exp(4*Z)*Z^3) \dots \\
& - (11*S^2.*Y.(S_v2)^2)/(exp(3*Z)*Z^3) + (4*S^2.*Y.(S_v2)^2)/(exp(2*Z)*Z^3) - (S^2.*Y.(S_v2)^2)/(2*\exp(Z)*Z^3) + (S^2.*Y.(S_v2)^2)/(2*\exp(Y.*Z)*Z^3) \dots \\
& + (9*\exp(-4*Z - Y.*Z)*S^2.*Y.(S_v2)^2)/(2*Z^3) - (12*\exp(-3*Z - Y.*Z)*S^2.*Y.(S_v2)^2)/Z^3 + (11*\exp(-2*Z - Y.*Z)*S^2.*Y.(S_v2)^2)/Z^3 \dots \\
& - (4*\exp(-Z - Y.*Z)*S^2.*Y.(S_v2)^2)/Z^3 + (S^2*(S_v2)^2)/(4*Z^2) + (9*S^2*(S_v2)^2)/(4*\exp(6*Z)*Z^2) - (3*S^2*(S_v2)^2)/(exp(5*Z)*Z^2) + (19*S^2*(S_v2)^2)/(exp(4*Z)*Z^2) \dots \\
& - (19*S^2*(S_v2)^2)/(exp(3*Z)*Z^2) + (35*S^2*(S_v2)^2)/(4*\exp(2*Z)*Z^2) - (2*S^2*(S_v2)^2)/(exp(Z)*Z^2) + (S^2*(S_v2)^2)/(4*\exp(4.*Y.*Z)*Z^2) \dots \\
& + (S^2*(S_v2)^2)/(2*\exp(2.*Y.*Z)*Z^2) + (\exp(-Z - 3.*Y.*Z)*S^2*(S_v2)^2)/Z^2 + (5*\exp(-2*Z - 2.*Y.*Z)*S^2*(S_v2)^2)/Z^2 - (2*\exp(-Z - 2.*Y.*Z)*S^2*(S_v2)^2)/Z^2 \dots \\
& - (9*\exp(-5*Z - Y.*Z)*S^2*(S_v2)^2)/(4*Z^2) + (3*\exp(-4*Z - Y.*Z)*S^2*(S_v2)^2)/Z^2 + (5*\exp(-3*Z - Y.*Z)*S^2*(S_v2)^2)/Z^2 - (\exp(-2*Z - Y.*Z)*S^2*(S_v2)^2)/Z^2 \dots \\
& + (\exp(-Z - Y.*Z)*S^2*(S_v2)^2)/(4*Z^2) - (S^2.*Y.(S_v2)^2)/(2*Z^2) - (15*S^2.*Y.(S_v2)^2)/(exp(4*Z)*Z^2) + (26*S^2.*Y.(S_v2)^2)/(exp(3*Z)*Z^2) \dots \\
& - (29*S^2.*Y.(S_v2)^2)/(2*\exp(2*Z)*Z^2) + (4*S^2.*Y.(S_v2)^2)/(exp(Z)*Z^2) - (S^2.*Y.(S_v2)^2)/(2*\exp(2.*Y.*Z)*Z^2) - (3*\exp(-2*Z - 2.*Y.*Z)*S^2.*Y.(S_v2)^2)/(2*Z^2) \dots \\
& + (2*\exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v2)^2)/Z^2 + (S^2.*Y.^2*(S_v2)^2)/(4*Z^2) + (9*S^2.*Y.^2*(S_v2)^2)/(4*\exp(6*Z)*Z^2) - (6*S^2.*Y.^2*(S_v2)^2)/(exp(5*Z)*Z^2) \dots \\
& + (31*S^2.*Y.^2*(S_v2)^2)/(4*\exp(4*Z)*Z^2) - (8*S^2.*Y.^2*(S_v2)^2)/(exp(3*Z)*Z^2) + (23*S^2.*Y.^2*(S_v2)^2)/(4*\exp(2*Z)*Z^2) - (2*S^2.*Y.^2*(S_v2)^2)/(exp(Z)*Z^2) \dots \\
& - (9*\exp(-5*Z - Y.*Z)*S^2.*Y.^2*(S_v2)^2)/(4*Z^2) + (6*\exp(-4*Z - Y.*Z)*S^2.*Y.^2*(S_v2)^2)/Z^2 - (11*\exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v2)^2)/(2*Z^2) \dots \\
& + (2*\exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v2)^2)/Z^2 - (\exp(-Z - Y.*Z)*S^2.*Y.^2*(S_v2)^2)/(4*Z^2) + (9*S^2*(S_v2)^2)/(2*\exp(5*Z)*Z) - (S^2*(S_v2)^2)/(exp(4*Z)*Z) \dots \\
& + (25*S^2*(S_v2)^2)/(4*\exp(3*Z)*Z) - (3*S^2*(S_v2)^2)/(exp(2*Z)*Z) + (3*S^2*(S_v2)^2)/(4*\exp(Z)*Z) + (3*\exp(-3*Z - 2.*Y.*Z)*S^2*(S_v2)^2)/(4*Z) \dots \\
& + (3*\exp(-Z - 2.*Y.*Z)*S^2*(S_v2)^2)/(4*Z) + (3*\exp(-4*Z - Y.*Z)*S^2*(S_v2)^2)/Z - (2*\exp(-3*Z - Y.*Z)*S^2*(S_v2)^2)/Z + (2*\exp(-2*Z - Y.*Z)*S^2*(S_v2)^2)/Z \dots \\
& - (9*S^2.*Y.(S_v2)^2)/(4*\exp(5*Z)*Z) + (3*S^2.*Y.(S_v2)^2)/(exp(4*Z)*Z) - (11*S^2.*Y.(S_v2)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.(S_v2)^2)/(exp(2*Z)*Z) \dots \\
& - (7*S^2.*Y.(S_v2)^2)/(4*\exp(Z)*Z) - (\exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v2)^2)/Z - (2*\exp(-2*Z - Y.*Z)*S^2.*Y.(S_v2)^2)/Z + (15*S^2.*Y.^2*(S_v2)^2)/(2*\exp(5*Z)*Z) \dots \\
& - (13*S^2.*Y.^2*(S_v2)^2)/(exp(4*Z)*Z) + (41*S^2.*Y.^2*(S_v2)^2)/(4*\exp(3*Z)*Z) - (6*S^2.*Y.^2*(S_v2)^2)/(exp(2*Z)*Z) + (5*S^2.*Y.^2*(S_v2)^2)/(4*\exp(Z)*Z) \dots \\
& + (3*\exp(-3*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v2)^2)/(4*Z) - (\exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v2)^2)/Z + (\exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v2)^2)/(4*Z) \dots \\
& - (9*S^2.*Y.^3*(S_v2)^2)/(4*\exp(5*Z)*Z) + (6*S^2.*Y.^3*(S_v2)^2)/(exp(4*Z)*Z) - (11*S^2.*Y.^3*(S_v2)^2)/(2*\exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v2)^2)/(exp(2*Z)*Z) \dots \\
& - (S^2.*Y.^3*(S_v2)^2)/(4*\exp(Z)*Z) - (3*S^2.*Z*(S_v2)^2)/(4*\exp(3*Z)) + (S^2.*Y.*Z*(S_v2)^2)/(exp(3*Z)) - (S^2.*Y.^2*Z*(S_v2)^2)/(exp(4*Z)) \dots \\
& + (S^2.*Y.^2*Z*(S_v2)^2)/(2*\exp(3*Z)) - (S^2.*Y.^3*Z*(S_v2)^2)/(exp(3*Z)) - (3*S^2.*Y.^4*Z*(S_v2)^2)/(4*\exp(5*Z)) - (S^2.*Y.^4*Z*(S_v2)^2)/(exp(4*Z)) \dots \\
& + (S^2.*Y.^4*Z*(S_v2)^2)/(4*\exp(3*Z)) + (S^2.*Z^2*Z*(S_v2)^2)/(4*\exp(4*Z)) - (S^2.*Y.^4*Z*(S_v2)^2)/(2*\exp(4*Z)) + (S^2.*Y.^4*Z*(S_v2)^2)/(4*\exp(4*Z)); 
\end{aligned}$$

Ns2=Nf+Nc+Ny2;  
 Phi2=Nf./[Nc+Ny2];  
 Be2=1./[1+Phi2];

```

Gf2=Nf./Ns2;
Gh2=[Nc+Ny2]./Ns2;
Nh2=Nc+Ny2;

```

```

S_v3=3;
Ny3=1 - exp(-2*Z) + exp(-Z - Y.*Z) - (2*S)/exp(2*Z) + 2*exp(-Z - Y.*Z)*S - S^2/exp(2*Z) + exp(-Z - Y.*Z)*S^2 - 2.*Y + Y.^2 + Y.^2/exp(2*Z) - exp(-Z - Y.*Z).*Y.^2 ...
+ (2*S.*Y.^2)/exp(2*Z) - 2*exp(-Z - Y.*Z)*S.*Y.^2 + (S^2.*Y.^2)/exp(2*Z) - exp(-Z - Y.*Z)*S^2.*Y.^2 + 1/(exp(2*Z)*Z^2) + 1./(exp(2.*Y.*Z)*Z^2) ...
- (2*exp(-Z - Y.*Z))/Z^2 + (2*S)/(exp(2*Z)*Z^2) + (2*S)./(exp(2.*Y.*Z)*Z^2) - (4*exp(-Z - Y.*Z)*S)/Z^2 + S^2/(exp(2*Z)*Z^2) + S^2./(exp(2.*Y.*Z)*Z^2) ...
- (2*exp(-Z - Y.*Z)*S^2)/Z^2 + 2/(exp(Z)*Z) - 2./((exp(Y.*Z)*Z) + (2*S)/(exp(Z)*Z) - (2*S)./(exp(Y.*Z)*Z) - (2.*Y)/(exp(Z)*Z) + (2.*Y)/(exp(Y.*Z)*Z) ...
- (2*S.*Y)/(exp(Z)*Z) + (2*S.*Y)/(exp(Y.*Z)*Z) - Z/exp(Z) - (S*Z)/exp(Z) + (Y.*Z)/exp(Z) + (S.*Y.*Z)/exp(Z) + (Y.^2*Z)/exp(Z) + (S.*Y.^2*Z)/exp(Z) - (Y.^3*Z)/exp(Z) ...
- (S.*Y.^3*Z)/exp(Z) + Z^2/(4*exp(2*Z)) + (S*Z^2)/(2*exp(2*Z)) + (S^2*Z^2)/(4*exp(2*Z)) - (Y.^2*Z^2)/(2*exp(2*Z)) - (S.*Y.^2*Z^2)/exp(2*Z) ...
- (S^2.*Y.^2*Z^2)/(2*exp(2*Z)) + (Y.^4*Z^2)/(4*exp(2*Z)) + (S.*Y.^4*Z^2)/(2*exp(2*Z)) + (S^2.*Y.^4*Z^2)/(4*exp(2*Z)) - (7*S*(S_v3))/(2*exp(3*Z)) ...
+ (2*S*(S_v3))/exp(2*Z) + (S*(S_v3))/exp(Z) - (exp(-Z - 2.*Y.*Z)*S*(S_v3))/2 - (5*S^2*(S_v3))/exp(3*Z) + (2*S^2*(S_v3))/exp(2*Z) - (S^2*(S_v3))/(2*exp(Z)) ...
- (exp(-Z - 2.*Y.*Z)*S^2*(S_v3))/2 - (2*S.*Y.*S*(S_v3))/exp(2*Z) - (3*S.*Y.*S*(S_v3))/exp(Z) + (3*S^2.*Y.*S*(S_v3))/(2*exp(3*Z)) - (2*S^2.*Y.*S*(S_v3))/exp(2*Z) ...
+ (S^2.*Y.*S*(S_v3))/(2*exp(Z)) + (13*S.*Y.^2*(S_v3))/(2*exp(3*Z)) - (4*S.*Y.^2*(S_v3))/exp(2*Z) + (3*S.*Y.^2*(S_v3))/exp(Z) + (exp(-Z - 2.*Y.*Z)*S.*Y.^2*(S_v3))/2 ...
+ (5*S^2.*Y.^2*(S_v3))/exp(3*Z) - (2*S^2.*Y.^2*(S_v3))/exp(2*Z) + (S^2.*Y.^2*(S_v3))/(2*exp(3*Z)) + (exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v3))/2 - (3*S.*Y.^3*(S_v3))/exp(3*Z) ...
+ (4*S.*Y.^3*(S_v3))/exp(2*Z) - (S.*Y.^3*(S_v3))/exp(Z) - (3*S^2.*Y.^3*(S_v3))/(2*exp(3*Z)) + (2*S^2.*Y.^3*(S_v3))/exp(2*Z) - (S^2.*Y.^3*(S_v3))/(2*exp(Z)) ...
+ (3*S*(S_v3))/(exp(4*Z)*Z^3) - (4*S*(S_v3))/(exp(3*Z)*Z^3) + (S*(S_v3))/(exp(2*Z)*Z^3) + (S*(S_v3))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S*(S_v3))/Z^3 ...
- (4*exp(-Z - 2.*Y.*Z)*S*(S_v3))/Z^3 - (6*exp(-3*Z - Y.*Z)*S*(S_v3))/Z^3 + (8*exp(-2*Z - Y.*Z)*S*(S_v3))/Z^3 - (2*exp(-Z - Y.*Z)*S*(S_v3))/Z^3 ...
+ (3*S^2*(S_v3))/(exp(4*Z)*Z^3) - (4*S^2*(S_v3))/(exp(3*Z)*Z^3) + (S^2*(S_v3))/(exp(2*Z)*Z^3) + (S^2*(S_v3))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v3))/Z^3 ...
- (4*exp(-Z - 2.*Y.*Z)*S^2*(S_v3))/Z^3 - (6*exp(-3*Z - Y.*Z)*S^2*(S_v3))/Z^3 + (8*exp(-2*Z - Y.*Z)*S^2*(S_v3))/Z^3 - (2*exp(-Z - Y.*Z)*S^2*(S_v3))/Z^3 ...
+ (11*S*(S_v3))/(exp(3*Z)*Z^2) - (8*S*(S_v3))/(exp(2*Z)*Z^2) + (2*S*(S_v3))/(exp(Z)*Z^2) - (S*(S_v3))./(exp(3.*Y.*Z)*Z^2) - (2*S*(S_v3))./(exp(Y.*Z)*Z^2) ...
- (exp(-Z - 2.*Y.*Z)*S*(S_v3))/Z^2 - (9*exp(-2*Z - Y.*Z)*S*(S_v3))/Z^2 + (8*exp(-Z - Y.*Z)*S*(S_v3))/Z^2 + (8*S^2*(S_v3))/exp(3*Z)*Z^2; ...
- (4*S^2*(S_v3))/(exp(2*Z)*Z^2) + (S^2*(S_v3))/(exp(Z)*Z^2) - (S^2*(S_v3))./(exp(3.*Y.*Z)*Z^2) - (S^2*(S_v3))./(exp(Y.*Z)*Z^2) - (exp(-Z - 2.*Y.*Z)*S^2*(S_v3))/Z^2 ...
- (6*exp(-2*Z - Y.*Z)*S^2*(S_v3))/Z^2 + (4*exp(-Z - Y.*Z)*S^2*(S_v3))/Z^2 - (6*S.*Y.*S*(S_v3))/(exp(3*Z)*Z^2) + (8*S.*Y.*S*(S_v3))/(exp(2*Z)*Z^2) ...
- (2*S.*Y.*S*(S_v3))/(exp(Z)*Z^2) + (2*S.*Y.*S*(S_v3))/(exp(Y.*Z)*Z^2) + (6*exp(-2*Z - Y.*Z)*S.*Y.*S*(S_v3))/Z^2 - (8*exp(-Z - Y.*Z)*S.*Y.*S*(S_v3))/Z^2 ...
- (3*S^2.*Y.*S*(S_v3))/(exp(3*Z)*Z^2) + (4*S^2.*Y.*S*(S_v3))/(exp(2*Z)*Z^2) - (S^2.*Y.*S*(S_v3))/(exp(Z)*Z^2) + (S^2.*Y.*S*(S_v3))/(exp(Y.*Z)*Z^2) ...
+ (3*exp(-2*Z - Y.*Z)*S^2.*Y.*S*(S_v3))/Z^2 - (4*exp(-Z - Y.*Z)*S^2.*Y.*S*(S_v3))/Z^2 + (S*(S_v3))/Z + (2*S*(S_v3))/(exp(3*Z)*Z) + (9*S*(S_v3))/(exp(2*Z)*Z) ...
- (4*S*(S_v3))/(exp(Z)*Z) + (S*(S_v3))./(exp(2.*Y.*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S*(S_v3))/Z + (exp(-Z - Y.*Z)*S*(S_v3))/Z + (2*S^2*(S_v3))/(exp(2*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S^2*(S_v3))/Z - (exp(-Z - Y.*Z)*S^2*(S_v3))/Z - (2*S.*Y.*S*(S_v3))/Z - (13*S.*Y.*S*(S_v3))/(exp(2*Z)*Z) ...

```

$$\begin{aligned}
& + \frac{(8*S.*Y.*(S_v3))/(exp(Z)*Z)}{(2*S^2.*Y.*(S_v3))/(exp(2*Z)*Z) + (2*exp(-Z - Y.*Z)*S^2.*Y.*(S_v3))/Z + (S.*Y.^2*(S_v3))/Z} \\
& + \frac{(3*S.*Y.^2*(S_v3))/(exp(4*Z)*Z)}{(4*S.*Y.^2*(S_v3))/(exp(2*Z)*Z) - (4*S.*Y.^2*(S_v3))/(exp(Z)*Z) ...} \\
& - \frac{(3*exp(-3*Z - Y.*Z)*S.*Y.^2*(S_v3))/Z}{(3*S^2.*Y.^2*(S_v3))/(exp(4*Z)*Z) ...} \\
& + \frac{(4*exp(-2*Z - Y.*Z)*S.*Y.^2*(S_v3))/Z}{(4*S^2.*Y.^2*(S_v3))/(exp(2*Z)*Z) - (exp(-Z - Y.*Z)*S.*Y.^2*(S_v3))/Z + (3*S^2.*Y.^2*(S_v3))/(exp(4*Z)*Z) ...} \\
& - \frac{(4*S^2.*Y.^2*(S_v3))/(exp(3*Z)*Z)}{(4*S^2.*Y.^2*(S_v3))/(exp(3*Z)*Z) + (S^2.*Y.^2*(S_v3))/(exp(2*Z)*Z) - (3*exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v3))/Z + (4*exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v3))/Z ...} \\
& - \frac{(3*S^2.*Y.^2*(S_v3))/(4*exp(4*Z)) - (3*S^2.*Z*(S_v3))/(4*exp(2*Z)) ...}{(2*S.*Y.^2*(S_v3))/(exp(2*Z) + (S^2.*Y.^2*(S_v3))/(exp(2*Z) + (S.*Y.^2*(S_v3))/exp(3*Z) + (3*S.*Y.^2*(S_v3))/(2*exp(2*Z)) + (S^2.*Y.^2*(S_v3))/(exp(3*Z) ...} \\
& + \frac{(S^2.*Y.^2*(S_v3))/(2*exp(2*Z))}{(2*S.*Y.^2*(S_v3))/(exp(2*Z) - (2*S.*Y.^2*(S_v3))/(exp(2*Z)) - (2*S.*Y.^2*(S_v3))/(4*exp(4*Z)) - (7*S^2.*Z*(S_v3))/(4*exp(2*Z))} \\
& - \frac{(3*S^2.*Z*(S_v3))/(4*exp(4*Z)) - (3*S^2.*Z*(S_v3))/(4*exp(2*Z)) ...}{(3*S^2.*Z*(S_v3))/(4*exp(4*Z)) - (3*S^2.*Z*(S_v3))/(4*exp(2*Z)) ...} \\
& + \frac{(2*S.*Y.^2*(S_v3))/(exp(2*Z) + (S^2.*Y.^2*(S_v3))/(exp(2*Z) + (S.*Y.^2*(S_v3))/exp(3*Z) + (3*S.*Y.^2*(S_v3))/(2*exp(2*Z)) + (S^2.*Y.^2*(S_v3))/(exp(3*Z) ...} \\
& + \frac{(S^2.*Y.^2*(S_v3))/(2*exp(2*Z))}{(2*S.*Y.^2*(S_v3))/(exp(2*Z) - (2*S.*Y.^2*(S_v3))/(exp(2*Z)) + (3*S.*Y.^2*(S_v3))/(4*exp(4*Z)) - (S.*Y.^4*(S_v3))/exp(3*Z) ...} \\
& ... \\
& + \frac{(S.*Y.^4*(S_v3))/(4*exp(2*Z))}{(S^2.*Y.^4*(S_v3))/exp(3*Z) + (S^2.*Y.^4*(S_v3))/(4*exp(2*Z)) + (S^2.*Y.^4*(S_v3))/(2*exp(3*Z))} \\
& ... \\
& + \frac{(S^2.*Z^2*(S_v3))/(2*exp(3*Z))}{(S^2.*Y.^2*(S_v3))/exp(3*Z) + (S.*Y.^4*(S_v3))/(2*exp(3*Z)) ...} \\
& + \frac{(S^2.*Y.^4*(S_v3))/(2*exp(3*Z))}{(9*S^2*(S_v3)^2)/(16*exp(6*Z))} \\
& (23*S^2*(S_v3)^2)/(8*exp(4*Z)) + (2*S^2*(S_v3)^2)/exp(3*Z) + (S^2*(S_v3)^2)/(16*exp(2*Z)) ... \\
& - \frac{(exp(-2*Z - 2.*Y.*Z)*S^2*(S_v3)^2)/2}{(exp(-3*Z - Y.*Z)*S^2*(S_v3)^2) - exp(-3*Z - Y.*Z)*S^2*(S_v3)^2} \\
& (2*S^2.*Y.^(S_v3)^2)/exp(3*Z) - (S^2.*Y.^(S_v3)^2)/exp(2*Z) + (9*S^2.*Y.^2*(S_v3)^2)/(8*exp(6*Z)) \\
& ... \\
& - \frac{(3*S^2.*Y.^2*(S_v3)^2)/(2*exp(5*Z))}{(7*S^2.*Y.^2*(S_v3)^2)/(2*exp(3*Z)) + (15*S^2.*Y.^2*(S_v3)^2)/(8*exp(2*Z)) ...} \\
& + \frac{(exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v3)^2)/2}{(exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v3)^2) + (3*S^2.*Y.^3*(S_v3)^2)/exp(4*Z) + (4*S^2.*Y.^3*(S_v3)^2)/exp(3*Z) ...} \\
& - \frac{(S^2.*Y.^3*(S_v3)^2)/exp(2*Z)}{(9*S^2.*Y.^4*(S_v3)^2)/(16*exp(6*Z))} \\
& (3*S^2.*Y.^4*(S_v3)^2)/(2*exp(5*Z)) + (11*S^2.*Y.^4*(S_v3)^2)/(8*exp(4*Z)) ... \\
& - \frac{(S^2.*Y.^4*(S_v3)^2)/(2*exp(3*Z))}{(9*S^2*(S_v3)^2)/(16*exp(2*Z))} \\
& (9*S^2*(S_v3)^2)/(4*exp(6*Z)*Z^4) - (6*S^2*(S_v3)^2)/(exp(5*Z)*Z^4) ... \\
& + \frac{(11*S^2*(S_v3)^2)/(2*exp(4*Z)*Z^4)}{(2*S^2*(S_v3)^2)/(exp(3*Z)*Z^4) + (S^2*(S_v3)^2)/(4*exp(2*Z)*Z^4) ...} \\
& + \frac{(9*exp(-4*Z - 2.*Y.*Z)*S^2*(S_v3)^2)/(4*Z^4)}{(6*exp(-3*Z - 2.*Y.*Z)*S^2*(S_v3)^2)/Z^4 + (11*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v3)^2)/(2*Z^4) ...} \\
& - \frac{(2*exp(-Z - 2.*Y.*Z)*S^2*(S_v3)^2)/Z^4}{(9*exp(-5*Z - Y.*Z)*S^2*(S_v3)^2)/(2*Z^4) + (12*exp(-4*Z - Y.*Z)*S^2*(S_v3)^2)/Z^4 - (11*exp(-3*Z - Y.*Z)*S^2*(S_v3)^2)/Z^4 ...} \\
& + \frac{(4*exp(-2*Z - Y.*Z)*S^2*(S_v3)^2)/Z^4}{(exp(-Z - Y.*Z)*S^2*(S_v3)^2)/(2*Z^4) - (exp(-Z - Y.*Z)*S^2*(S_v3)^2)/(2*Z^4) + (12*S^2*(S_v3)^2)/(exp(5*Z)*Z^3) - (22*S^2*(S_v3)^2)/(exp(4*Z)*Z^3) ...} \\
& + \frac{(27*S^2*(S_v3)^2)/(2*exp(3*Z)*Z^3)}{(4*S^2*(S_v3)^2)/(exp(2*Z)*Z^3) + (S^2*(S_v3)^2)/(2*exp(Z)*Z^3) - (S^2*(S_v3)^2)/(2*exp(Y.*Z)*Z^3) - (3*exp(-2*Z - 3.*Y.*Z)*S^2*(S_v3)^2)/(2*Z^3) + (2*exp(-Z - 3.*Y.*Z)*S^2*(S_v3)^2)/Z^3 - (3*exp(-3*Z - 2.*Y.*Z)*S^2*(S_v3)^2)/(2*Z^3) ...} \\
& + \frac{(2*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v3)^2)/Z^3}{(exp(-Z - 2.*Y.*Z)*S^2*(S_v3)^2)/(2*Z^3) - (9*exp(-4*Z - Y.*Z)*S^2*(S_v3)^2)/(2*Z^3) + (18*exp(-3*Z - Y.*Z)*S^2*(S_v3)^2)/(2*Z^3) ...} \\
& - \frac{(25*exp(-2*Z - Y.*Z)*S^2*(S_v3)^2)/(2*Z^3)}{(4*exp(-Z - Y.*Z)*S^2*(S_v3)^2)/(Z^3) + (9*S^2.*Y.^(S_v3)^2)/(2*exp(5*Z)*Z^3) + (12*S^2.*Y.^(S_v3)^2)/(exp(4*Z)*Z^3) ...} \\
& - \frac{(11*S^2.*Y.^(S_v3)^2)/(exp(3*Z)*Z^3)}{(S^2.*Y.^(S_v3)^2)/(2*exp(Z)*Z^3) + (S^2.*Y.^(S_v3)^2)/(2*exp(Y.*Z)*Z^3) ...} \\
& + \frac{(9*exp(-4*Z - Y.*Z)*S^2.*Y.^(S_v3)^2)/(2*Z^3)}{(12*exp(-3*Z - Y.*Z)*S^2.*Y.^(S_v3)^2)/(2*Z^3) + (11*exp(-2*Z - Y.*Z)*S^2.*Y.^(S_v3)^2)/(Z^3) ...} \\
& - \frac{(4*exp(-Z - Y.*Z)*S^2.*Y.^(S_v3)^2)/(Z^3)}{(S^2.*Y.^(S_v3)^2)/(4*exp(6*Z)*Z^2) - (3*S^2*(S_v3)^2)/(exp(5*Z)*Z^2) + (19*S^2*(S_v3)^2)/(exp(4*Z)*Z^2) ...} \\
\end{aligned}$$

$$\begin{aligned}
& - \frac{(19*S^2*(S_v3)^2)/(exp(3*Z)*Z^2)}{(2*S^2*(S_v3)^2)/(exp(Z)*Z^2) + (S^2*(S_v3)^2)./(4*exp(4.*Y.*Z)*Z^2)} + \frac{(35*S^2*(S_v3)^2)/(4*exp(2*Z)*Z^2)}{(S^2*(S_v3)^2)./(2*exp(2.*Y.*Z)*Z^2) + (exp(-Z - 3.*Y.*Z)*S^2*(S_v3)^2)/Z^2} \\
& + \frac{(S^2*(S_v3)^2)./(2*exp(2.*Y.*Z)*Z^2) + (exp(-Z - 3.*Y.*Z)*S^2*(S_v3)^2)/Z^2}{(5*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v3)^2)/Z^2} \\
& - \frac{(9*exp(-5*Z - Y.*Z)*S^2*(S_v3)^2)/(4*Z^2)}{(2*exp(-Z - 2.*Y.*Z)*S^2*(S_v3)^2)/Z^2} + \frac{(3*exp(-4*Z - Y.*Z)*S^2*(S_v3)^2)/(Z^2)}{(5*exp(-3*Z - Y.*Z)*S^2*(S_v3)^2)/Z^2} \\
& + \frac{(exp(-Z - 2.*Y.*Z)*S^2*(S_v3)^2)/(4*Z^2)}{(S^2.*Y.(S_v3)^2)/(exp(4*Z)*Z^2)} - \frac{(S^2.*Y.(S_v3)^2)/(2*Z^2)}{(S^2.*Y.(S_v3)^2)/(2*exp(4*Z)*Z^2)} \\
& - \frac{(15*S^2.*Y.(S_v3)^2)/(exp(4*Z)*Z^2) + (26*S^2.*Y.(S_v3)^2)/(exp(3*Z)*Z^2)}{(29*S^2.*Y.(S_v3)^2)/(2*exp(2*Z)*Z^2)} + \frac{(4*S^2.*Y.(S_v3)^2)/(exp(Z)*Z^2)}{(S^2.*Y.(S_v3)^2)/(2*exp(2.*Y.*Z)*Z^2)} \\
& + \frac{(2*exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v3)^2)/Z^2}{(S^2.*Y.^2*(S_v3)^2)/(4*Z^2)} + \frac{(S^2.*Y.^2*(S_v3)^2)/(4*Z^2)}{(9*S^2.*Y.^2*(S_v3)^2)/(4*exp(6*Z)*Z^2)} \\
& + \frac{(31*S^2.*Y.^2*(S_v3)^2)/(4*exp(4*Z)*Z^2)}{(6*S^2.*Y.^2*(S_v3)^2)/(exp(5*Z)*Z^2)} + \frac{(8*S^2.*Y.^2*(S_v3)^2)/(exp(3*Z)*Z^2)}{(23*S^2.*Y.^2*(S_v3)^2)/(4*exp(2*Z)*Z^2)} \\
& - \frac{(2*S^2.*Y.^2*(S_v3)^2)/(exp(Z)*Z^2)}{(9*exp(-5*Z - Y.*Z)*S^2.*Y.^2*(S_v3)^2)/(4*Z^2)} + \frac{(6*exp(-4*Z - Y.*Z)*S^2.*Y.^2*(S_v3)^2)/(Z^2)}{(11*exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v3)^2)/(2*Z^2)} \\
& + \frac{(2*exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v3)^2)/Z^2}{(exp(-Z - Y.*Z)*S^2.*Y.^2*(S_v3)^2)/(4*Z^2)} - \frac{(exp(-Z - Y.*Z)*S^2.*Y.^2*(S_v3)^2)/(4*Z^2)}{(9*S^2*(S_v3)^2)/(2*exp(5*Z)*Z)} \\
& - \frac{(S^2*(S_v3)^2)/(exp(4*Z)*Z)}{(25*S^2*(S_v3)^2)/(4*exp(3*Z)*Z)} - \frac{(3*S^2*(S_v3)^2)/(exp(2*Z)*Z)}{(3*S^2*(S_v3)^2)/(4*exp(Z)*Z)} \\
& + \frac{(3*exp(-3*Z - 2.*Y.*Z)*S^2*(S_v3)^2)/(4*Z)}{(2*exp(-3*Z - Y.*Z)*S^2*(S_v3)^2)/Z} - \frac{(2*exp(-3*Z - Y.*Z)*S^2*(S_v3)^2)/Z}{(2*exp(-3*Z - Y.*Z)*S^2*(S_v3)^2)/Z} \\
& - \frac{(9*S^2.*Y.(S_v3)^2)/(4*exp(5*Z)*Z)}{(11*S^2.*Y.(S_v3)^2)/(exp(3*Z)*Z)} + \frac{(7*S^2.*Y.(S_v3)^2)/(exp(2*Z)*Z)}{(13*S^2.*Y.^2*(S_v3)^2)/(exp(4*Z)*Z)} \\
& - \frac{(7*S^2.*Y.(S_v3)^2)/(4*exp(Z)*Z)}{(exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v3)^2)/Z} - \frac{(exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v3)^2)/Z}{(2*exp(-2*Z - Y.*Z)*S^2.*Y.(S_v3)^2)/Z} \\
& + \frac{(15*S^2.*Y.^2*(S_v3)^2)/(2*exp(5*Z)*Z)}{(13*S^2.*Y.^2*(S_v3)^2)/(4*exp(3*Z)*Z)} - \frac{(41*S^2.*Y.^2*(S_v3)^2)/(4*exp(3*Z)*Z)}{(6*S^2.*Y.^2*(S_v3)^2)/(exp(2*Z)*Z)} \\
& + \frac{(5*S^2.*Y.^2*(S_v3)^2)/(4*exp(Z)*Z)}{(3*exp(-3*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v3)^2)/(4*Z)} - \frac{(exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v3)^2)/(Z)}{(exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v3)^2)/(4*Z)} \\
& - \frac{(9*S^2.*Y.^2*(S_v3)^2)/(4*exp(5*Z)*Z)}{(11*S^2.*Y.^2*(S_v3)^2)/(2*exp(3*Z)*Z)} + \frac{(6*S^2.*Y.^2*(S_v3)^2)/(exp(2*Z)*Z)}{(11*S^2.*Y.^2*(S_v3)^2)/(4*exp(Z)*Z)} \\
& - \frac{(S^2.*Y.^2*(S_v3)^2)/(4*exp(Z)*Z)}{(3*S^2.*Z*(S_v3)^2)/(4*exp(3*Z))} + \frac{(S^2.*Y.^2*(S_v3)^2)/(exp(3*Z))}{(S^2.*Y.^2*(S_v3)^2)/exp(4*Z)} \\
& + \frac{(S^2.*Y.^2*(S_v3)^2)/(2*exp(3*Z))}{(3*S^2.*Y.^2*(S_v3)^2)/(4*exp(5*Z)*Z)} - \frac{(S^2.*Y.^2*(S_v3)^2)/(exp(4*Z)*Z)}{(3*S^2.*Y.^2*(S_v3)^2)/(4*exp(5*Z)*Z)} \\
& + \frac{(S^2.*Y.^2*(S_v3)^2)/(4*exp(3*Z))}{(S^2.*Y.^2*(S_v3)^2)/(4*exp(3*Z))} + \frac{(S^2.*Y.^2*(S_v3)^2)/(4*exp(4*Z))}{(S^2.*Y.^2*(S_v3)^2)/(2*exp(4*Z))} \\
& - \frac{(S^2.*Y.^2*(S_v3)^2)/(2*exp(4*Z))}{(S^2.*Y.^2*(S_v3)^2)/(4*exp(4*Z))} + \frac{(S^2.*Y.^2*(S_v3)^2)/(4*exp(4*Z))}{(S^2.*Y.^2*(S_v3)^2)/(2*exp(4*Z))} + \frac{(S^2.*Y.^2*(S_v3)^2)/(4*exp(4*Z))}{(S^2.*Y.^2*(S_v3)^2)/(4*exp(4*Z))};
\end{aligned}$$

Ns3=Nf+Nc+Ny3;  
 Phi3=Nf./[Nc+Ny3];  
 Be3=1./[1+Phi3];  
 Gf3=Nf./Ns3;  
 Gh3=[Nc+Ny3]./Ns3;  
 Nh3=Nc+Ny3;

$$\begin{aligned}
& S_v4=4; \\
& Ny4=1 - exp(-2*Z) + exp(-Z - Y.*Z) - (2*S)/exp(2*Z) + 2*exp(-Z - Y.*Z)*S - S^2/exp(2*Z) + exp(-Z - Y.*Z)*S^2 - 2.*Y + Y.^2 + Y.^2/exp(2*Z) - exp(-Z - Y.*Z).*Y.^2 ... \\
& + (2*S.*Y.^2)/exp(2*Z) - 2*exp(-Z - Y.*Z)*S.*Y.^2 + (S^2.*Y.^2)/exp(2*Z) - exp(-Z - Y.*Z)*S^2.*Y.^2 + 1/(exp(2*Z)*Z^2) + 1/(exp(2.*Y.*Z)*Z^2) ... \\
& - (2*exp(-Z - Y.*Z))/Z^2 + (2*S)/(exp(2*Z)*Z^2) + (2*S)./(exp(2.*Y.*Z)*Z^2) - (4*exp(-Z - Y.*Z)*S)/Z^2 + S^2/(exp(2*Z)*Z^2) + S^2./(exp(2.*Y.*Z)*Z^2) ...
\end{aligned}$$

$$\begin{aligned}
& - (2*\exp(-Z - Y.*Z)*S^2)/Z^2 + 2/(\exp(Z)*Z) - 2./(\exp(Y.*Z)*Z) + (2*S)/(\exp(Z)*Z) - \\
& (2*S)./(\exp(Y.*Z)*Z) - (2.*Y)/(\exp(Z)*Z) + (2.*Y)/(\exp(Y.*Z)*Z) ... \\
& - (2*S.*Y)/(\exp(Z)*Z) + (2*S.*Y)/(\exp(Y.*Z)*Z) - Z/\exp(Z) - (S*Z)/\exp(Z) + (Y.*Z)/\exp(Z) + \\
& (S.*Y.*Z)/\exp(Z) + (Y.^2*Z)/\exp(Z) + (S.*Y.^2*Z)/\exp(Z) - (Y.^3*Z)/\exp(Z) ... \\
& - (S.*Y.^3*Z)/\exp(Z) + Z^2/(4*\exp(2*Z)) + (S*Z^2)/(2*\exp(2*Z)) + (S^2*Z^2)/(4*\exp(2*Z)) - \\
& (Y.^2*Z^2)/(2*\exp(2*Z)) - (S.*Y.^2*Z^2)/\exp(2*Z) ... \\
& - (S^2.*Y.^2*Z^2)/(2*\exp(2*Z)) + (Y.^4*Z^2)/(4*\exp(2*Z)) + (S.*Y.^4*Z^2)/(2*\exp(2*Z)) + \\
& (S^2.*Y.^4*Z^2)/(4*\exp(2*Z)) - (7*S*(S_v4))/(2*\exp(3*Z)) ... \\
& + (2*S*(S_v4))/\exp(2*Z) + (S*(S_v4))/\exp(Z) - (\exp(-Z - 2.*Y.*Z)*S*(S_v4))/2 - \\
& (5*S^2*(S_v4))/\exp(3*Z) + (2*S^2*(S_v4))/\exp(2*Z) - (S^2*(S_v4))/(2*\exp(Z)) ... \\
& - (\exp(-Z - 2.*Y.*Z)*S^2*(S_v4))/2 - (2*S.*Y.*S*(S_v4))/\exp(2*Z) - (3*S.*Y.*S*(S_v4))/\exp(Z) + \\
& (3*S^2.*Y.*S*(S_v4))/(2*\exp(3*Z)) - (2*S^2.*Y.*S*(S_v4))/\exp(2*Z) ... \\
& + (S^2.*Y.*S*(S_v4))/(2*\exp(Z)) + (13*S.*Y.^2*(S_v4))/(2*\exp(3*Z)) - (4*S.*Y.^2*(S_v4))/\exp(2*Z) + \\
& (3*S.*Y.^2*(S_v4))/\exp(Z) + (\exp(-Z - 2.*Y.*Z)*S.*Y.^2*(S_v4))/2 ... \\
& + (5*S^2.*Y.^2*(S_v4))/\exp(3*Z) - (2*S^2.*Y.^2*(S_v4))/\exp(2*Z) + (S^2.*Y.^2*(S_v4))/(2*\exp(Z)) + \\
& (\exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v4))/2 - (3*S.*Y.^3*(S_v4))/\exp(3*Z) ... \\
& + (4*S.*Y.^3*(S_v4))/\exp(2*Z) - (S.*Y.^3*(S_v4))/\exp(Z) - (3*S^2.*Y.^3*(S_v4))/(2*\exp(3*Z)) + \\
& (2*S^2.*Y.^3*(S_v4))/\exp(2*Z) - (S^2.*Y.^3*(S_v4))/(2*\exp(Z)) ... \\
& + (3*S*(S_v4))/(exp(4*Z)*Z^3) - (4*S*(S_v4))/(exp(3*Z)*Z^3) + (S*(S_v4))/(exp(2*Z)*Z^3) + \\
& (S*(S_v4))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S*(S_v4))/Z^3 ... \\
& - (4*exp(-Z - 2.*Y.*Z)*S*(S_v4))/Z^3 - (6*exp(-3*Z - Y.*Z)*S*(S_v4))/Z^3 + (8*exp(-2*Z - \\
& Y.*Z)*S*(S_v4))/Z^3 - (2*exp(-Z - Y.*Z)*S*(S_v4))/Z^3 ... \\
& + (3*S^2*(S_v4))/(exp(4*Z)*Z^3) - (4*S^2*(S_v4))/(exp(3*Z)*Z^3) + (S^2*(S_v4))/(exp(2*Z)*Z^3) + \\
& (S^2*(S_v4))./(exp(2.*Y.*Z)*Z^3) + (3*exp(-2*Z - 2.*Y.*Z)*S^2*(S_v4))/Z^3 ... \\
& - (4*exp(-Z - 2.*Y.*Z)*S^2*(S_v4))/Z^3 - (6*exp(-3*Z - Y.*Z)*S^2*(S_v4))/Z^3 + (8*exp(-2*Z - \\
& Y.*Z)*S^2*(S_v4))/Z^3 - (2*exp(-Z - Y.*Z)*S^2*(S_v4))/Z^3 ... \\
& + (11*S*(S_v4))/(exp(3*Z)*Z^2) - (8*S*(S_v4))/(exp(2*Z)*Z^2) + (2*S*(S_v4))/(exp(Z)*Z^2) - \\
& (S*(S_v4))./(exp(3.*Y.*Z)*Z^2) - (2*S*(S_v4))./(exp(Y.*Z)*Z^2) ... \\
& - (\exp(-Z - 2.*Y.*Z)*S*(S_v4))/Z^2 - (9*exp(-2*Z - Y.*Z)*S*(S_v4))/Z^2 + (8*exp(-Z - \\
& Y.*Z)*S*(S_v4))/Z^2 + (8*S^2*(S_v4))/(exp(3*Z)*Z^2); ... \\
& - (4*S^2*(S_v4))/(exp(2*Z)*Z^2) + (S^2*(S_v4))/(exp(Z)*Z^2) - (S^2*(S_v4))./(exp(3.*Y.*Z)*Z^2) - \\
& (S^2*(S_v4))./(exp(Y.*Z)*Z^2) - (\exp(-Z - 2.*Y.*Z)*S^2*(S_v4))/Z^2 ... \\
& - (6*exp(-2*Z - Y.*Z)*S^2*(S_v4))/Z^2 + (4*exp(-Z - Y.*Z)*S^2*(S_v4))/Z^2 - \\
& (6*S.*Y.*S*(S_v4))/(exp(3*Z)*Z^2) + (8*S.*Y.*S*(S_v4))/(exp(2*Z)*Z^2) ... \\
& - (2*S.*Y.*S*(S_v4))/(exp(Z)*Z^2) + (2*S.*Y.*S*(S_v4))/(exp(Y.*Z)*Z^2) + (6*exp(-2*Z - \\
& Y.*Z)*S.*Y.*S*(S_v4))/Z^2 - (8*exp(-Z - Y.*Z)*S.*Y.*S*(S_v4))/Z^2 ... \\
& - (3*S^2.*Y.*S*(S_v4))/(exp(3*Z)*Z^2) + (4*S^2.*Y.*S*(S_v4))/(exp(2*Z)*Z^2) - \\
& (S^2.*Y.*S*(S_v4))/(exp(Z)*Z^2) + (S^2.*Y.*S*(S_v4))/(exp(Y.*Z)*Z^2) ... \\
& + (3*exp(-2*Z - Y.*Z)*S^2.*Y.*S*(S_v4))/Z^2 - (4*exp(-Z - Y.*Z)*S^2.*Y.*S*(S_v4))/Z^2 + (S*(S_v4))/Z \\
& + (2*S*(S_v4))/(exp(3*Z)*Z) + (9*S*(S_v4))/(exp(2*Z)*Z)... \\
& - (4*S*(S_v4))/(exp(Z)*Z) + (S*(S_v4))./(exp(2.*Y.*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S*(S_v4))/Z + \\
& (\exp(-Z - Y.*Z)*S*(S_v4))/Z + (2*S^2*(S_v4))/(exp(3*Z)*Z) ... \\
& + (S^2*(S_v4))/(exp(2*Z)*Z) - (2*exp(-2*Z - Y.*Z)*S^2*(S_v4))/Z - (\exp(-Z - Y.*Z)*S^2*(S_v4))/Z - \\
& (2*S.*Y.*S*(S_v4))/Z - (13*S.*Y.*S*(S_v4))/(exp(2*Z)*Z) ... \\
& + (8*S.*Y.*S*(S_v4))/(exp(Z)*Z) - (S.*Y.*S*(S_v4))./(exp(2.*Y.*Z)*Z) - \\
& (2*S^2.*Y.*S*(S_v4))/(exp(2*Z)*Z) + (2*S^2.*Y.*S*(S_v4))/\exp(2*Z) ... \\
& + (3*S.*Y.^2*(S_v4))/(exp(4*Z)*Z) - (4*S.*Y.^2*(S_v4))/(exp(3*Z)*Z) ... \\
& - (3*exp(-3*Z - Y.*Z)*S.*Y.^2*(S_v4))/Z + (4*exp(-2*Z - Y.*Z)*S.*Y.^2*(S_v4))/Z - (\exp(-Z - \\
& Y.*Z)*S.*Y.^2*(S_v4))/Z + (3*S^2.*Y.^2*(S_v4))/(exp(4*Z)*Z) ... \\
& - (4*S^2.*Y.^2*(S_v4))/(exp(3*Z)*Z) + (S^2.*Y.^2*(S_v4))/(exp(2*Z)*Z) - (3*exp(-3*Z - \\
& Y.*Z)*S^2.*Y.^2*(S_v4))/Z + (4*exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v4))/Z ... \\
& - (\exp(-Z - Y.*Z)*S^2.*Y.^2*(S_v4))/Z - (3*S^2*(S_v4))/(4*exp(4*Z)) - (7*S^2*(S_v4))/(4*exp(2*Z)) \\
& - (3*S^2*(S_v4))/(4*exp(4*Z)) - (3*S^2*(S_v4))/(4*exp(2*Z)) ... \\
& + (2*S.*Y.*Z*(S_v4))/\exp(2*Z) + (S^2.*Y.*Z*(S_v4))/\exp(2*Z) + (S.*Y.^2*Z*(S_v4))/\exp(3*Z) + \\
& (3*S.*Y.^2*Z*(S_v4))/(2*\exp(2*Z)) + (S^2.*Y.^2*Z*(S_v4))/\exp(3*Z) ...
\end{aligned}$$

$$\begin{aligned}
& + \frac{(S^2.*Y.^2*Z*(S_v4))/(2*\exp(2*Z))}{(S^2.*Y.^3*Z*(S_v4))/\exp(2*Z)} - \frac{(2*S.*Y.^3*Z*(S_v4))/\exp(2*Z)}{(S^2.*Y.^4*Z*(S_v4))/\exp(3*Z)} \\
& \dots \\
& + \frac{(S.*Y.^4*Z*(S_v4))/(4*\exp(2*Z))}{(S^2.*Y.^4*Z*(S_v4))/\exp(3*Z)} + \frac{(3*S^2.*Y.^4*Z*(S_v4))/(4*\exp(4*Z))}{(S^2.*Y.^4*Z*(S_v4))/\exp(3*Z)} \\
& \dots \\
& + \frac{(S^2.*Y.^4*Z*(S_v4))/(4*\exp(2*Z))}{(S^2.*Y.^4*Z*(S_v4))/\exp(3*Z)} + \frac{(3*S^2.*Y.^4*Z*(S_v4))/(4*\exp(4*Z))}{(S^2.*Y.^4*Z*(S_v4))/\exp(3*Z)} \\
& \dots \\
& + \frac{(S^2.*Y.^2*Z^2*(S_v4))/(2*\exp(3*Z))}{(S^2.*Y.^2*Z^2*(S_v4))/\exp(3*Z)} + \frac{(S.*Y.^2*Z^2*(S_v4))/\exp(3*Z)}{(S^2.*Y.^4*Z^2*(S_v4))/\exp(3*Z)} \\
& + \frac{(S^2.*Y.^4*Z^2*(S_v4))/(2*\exp(3*Z))}{(S^2.*Y.^4*Z^2*(S_v4))/\exp(3*Z)} + \frac{(9*S^2*(S_v4)^2)/(16*\exp(6*Z))}{(23*S^2*(S_v4)^2)/(8*\exp(4*Z))} \\
& - \frac{(\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v4)^2)/2}{(2*S^2*(S_v4)^2)/\exp(3*Z)} - \frac{\exp(-3*Z) - Y.*Z)*S^2*(S_v4)^2}{(S^2*(S_v4)^2)/(16*\exp(2*Z))} \\
& - \frac{(2*S^2.*Y.*(S_v4)^2)/\exp(3*Z)}{(2*S^2.*Y.*(S_v4)^2)/\exp(2*Z)} - \frac{(9*S^2.*Y.^2*(S_v4)^2)/(8*\exp(6*Z))}{(2*S^2.*Y.*(S_v4)^2)/\exp(3*Z)} \\
& \dots \\
& - \frac{(3*S^2.*Y.^2*(S_v4)^2)/(2*\exp(5*Z))}{(7*S^2.*Y.^2*(S_v4)^2)/(2*\exp(3*Z))} + \frac{(11*S^2.*Y.^2*(S_v4)^2)/(2*\exp(4*Z))}{(15*S^2.*Y.^2*(S_v4)^2)/(8*\exp(2*Z))} \\
& + \frac{(\exp(-2*Z) - 2.*Y.*Z)*S^2.*Y.^2*(S_v4)^2)/2}{(3*S^2.*Y.^2*(S_v4)^2)/(2*\exp(5*Z))} + \frac{\exp(-3*Z) - Y.*Z)*S^2.*Y.^2*(S_v4)^2}{(11*S^2.*Y.^2*(S_v4)^2)/(8*\exp(4*Z))} \\
& - \frac{(S^2.*Y.^4*(S_v4)^2)/(2*\exp(3*Z))}{(9*S^2*(S_v4)^2)/(4*\exp(6*Z)*Z^4)} - \frac{(6*S^2*(S_v4)^2)/(exp(5*Z)*Z^4)}{(6*S^2*(S_v4)^2)/(exp(5*Z)*Z^4)} \\
& + \frac{(11*S^2*(S_v4)^2)/(2*\exp(4*Z)*Z^4)}{(9*S^2*(S_v4)^2)/(4*\exp(6*Z)*Z^4)} - \frac{(2*S^2*(S_v4)^2)/(exp(3*Z)*Z^4)}{(S^2*(S_v4)^2)/(4*\exp(2*Z)*Z^4)} \\
& + \frac{(9*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v4)^2)/(4*Z^4)}{(9*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(4*Z^4)} - \frac{(6*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^4}{(6*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^4} \\
& + \frac{(11*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(2*Z^4)}{(11*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(2*Z^4)} - \frac{(2*\exp(-Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^4}{(2*\exp(-Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^4} \\
& - \frac{(9*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^4}{(9*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^4} - \frac{(12*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^4}{(12*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^4} \\
& + \frac{(27*S^2*(S_v4)^2)/(2*\exp(3*Z)*Z^3)}{(27*S^2*(S_v4)^2)/(2*\exp(3*Z)*Z^3)} - \frac{(4*S^2*(S_v4)^2)/(exp(2*Z)*Z^3)}{(4*S^2*(S_v4)^2)/(exp(2*Z)*Z^3)} \\
& - \frac{(S^2*(S_v4)^2)/(2*\exp(Z)*Z^3)}{(S^2*(S_v4)^2)/(2*\exp(Z)*Z^3)} - \frac{(S^2*(S_v4)^2)/(2*\exp(3.*Y.*Z)*Z^3)}{(S^2*(S_v4)^2)/(2*\exp(3.*Y.*Z)*Z^3)} \\
& - \frac{(S^2*(S_v4)^2)/(2*\exp(Y.*Z)*Z^3)}{(S^2*(S_v4)^2)/(2*\exp(Y.*Z)*Z^3)} - \frac{(3*\exp(-2*Z) - 3.*Y.*Z)*S^2*(S_v4)^2/(2*Z^3)}{(3*\exp(-2*Z) - 3.*Y.*Z)*S^2*(S_v4)^2/(2*Z^3)} \\
& + \frac{(2*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^3}{(2*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^3} - \frac{(\exp(-Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(2*Z^3)}{(\exp(-Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(2*Z^3)} \\
& - \frac{(9*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^3}{(9*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^3} + \frac{(18*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^3}{(18*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^3} \\
& - \frac{(25*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(2*Z^3)}{(25*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(2*Z^3)} + \frac{(4*\exp(-Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^3}{(4*\exp(-Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^3} \\
& - \frac{(9*S^2.*Y.(S_v4)^2)/(2*\exp(5*Z)*Z^3)}{(9*S^2.*Y.(S_v4)^2)/(2*\exp(5*Z)*Z^3)} + \frac{(12*S^2.*Y.(S_v4)^2)/(exp(4*Z)*Z^3)}{(12*S^2.*Y.(S_v4)^2)/(exp(4*Z)*Z^3)} \\
& - \frac{(11*S^2.*Y.(S_v4)^2)/(exp(3*Z)*Z^3)}{(11*S^2.*Y.(S_v4)^2)/(exp(3*Z)*Z^3)} + \frac{(4*S^2.*Y.(S_v4)^2)/(exp(2*Z)*Z^3)}{(4*S^2.*Y.(S_v4)^2)/(exp(2*Z)*Z^3)} \\
& - \frac{(S^2.*Y.(S_v4)^2)/(2*\exp(Z)*Z^3)}{(S^2.*Y.(S_v4)^2)/(2*\exp(Z)*Z^3)} + \frac{(S^2.*Y.(S_v4)^2)/(2*\exp(Y.*Z)*Z^3)}{(S^2.*Y.(S_v4)^2)/(2*\exp(Y.*Z)*Z^3)} \\
& + \frac{(9*\exp(-4*Z) - 2.*Y.*Z)*S^2.*Y.(S_v4)^2/(2*Z^3)}{(9*\exp(-4*Z) - 2.*Y.*Z)*S^2.*Y.(S_v4)^2/(2*Z^3)} - \frac{(12*\exp(-3*Z) - 2.*Y.*Z)*S^2.*Y.(S_v4)^2/Z^3}{(12*\exp(-3*Z) - 2.*Y.*Z)*S^2.*Y.(S_v4)^2/Z^3} \\
& + \frac{(11*\exp(-2*Z) - 2.*Y.*Z)*S^2.*Y.(S_v4)^2/Z^3}{(11*\exp(-2*Z) - 2.*Y.*Z)*S^2.*Y.(S_v4)^2/Z^3} - \frac{(4*\exp(-Z) - 2.*Y.*Z)*S^2.*Y.(S_v4)^2/Z^3}{(4*\exp(-Z) - 2.*Y.*Z)*S^2.*Y.(S_v4)^2/Z^3} \\
& - \frac{(9*S^2*(S_v4)^2)/(4*\exp(6*Z)*Z^2)}{(9*S^2*(S_v4)^2)/(4*\exp(6*Z)*Z^2)} - \frac{(3*S^2*(S_v4)^2)/(exp(5*Z)*Z^2)}{(3*S^2*(S_v4)^2)/(exp(5*Z)*Z^2)} \\
& - \frac{(19*S^2*(S_v4)^2)/(exp(4*Z)*Z^2)}{(19*S^2*(S_v4)^2)/(exp(4*Z)*Z^2)} - \frac{(19*S^2*(S_v4)^2)/(exp(3*Z)*Z^2)}{(2*S^2*(S_v4)^2)/(exp(Z)*Z^2)} + \frac{(35*S^2*(S_v4)^2)/(4*\exp(2*Z)*Z^2)}{(S^2*(S_v4)^2)/(4*\exp(4*Y.*Z)*Z^2)} \\
& + \frac{(S^2*(S_v4)^2)/(2*\exp(2.*Y.*Z)*Z^2)}{(S^2*(S_v4)^2)/(2*\exp(2.*Y.*Z)*Z^2)} + \frac{(\exp(-Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^2}{(\exp(-Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^2} + \frac{(5*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^2}{(5*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^2} \\
& - \frac{(9*\exp(-5*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(4*Z^2)}{(9*\exp(-5*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(4*Z^2)} + \frac{(3*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^2}{(3*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^2} + \frac{(5*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^2}{(5*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v4)^2/Z^2} \\
& + \frac{(\exp(-Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(4*Z^2)}{(15*S^2.*Y.(S_v4)^2)/(exp(4*Z)*Z^2)} - \frac{(\exp(-Z) - 2.*Y.*Z)*S^2*(S_v4)^2/(4*Z^2)}{(26*S^2.*Y.(S_v4)^2)/(exp(3*Z)*Z^2)} \\
& - \frac{(29*S^2.*Y.(S_v4)^2)/(2*\exp(2*Z)*Z^2)}{(29*S^2.*Y.(S_v4)^2)/(2*\exp(2*Z)*Z^2)} + \frac{(4*S^2.*Y.(S_v4)^2)/(exp(Z)*Z^2)}{(S^2.*Y.(S_v4)^2)/(2*\exp(2.*Y.*Z)*Z^2)} \\
& + \frac{(2*\exp(-Z) - 2.*Y.*Z)*S^2.*Y.(S_v4)^2/Z^2}{(2*\exp(-Z) - 2.*Y.*Z)*S^2.*Y.(S_v4)^2/Z^2} + \frac{(S^2.*Y.^2*(S_v4)^2)/(4*Z^2)}{(S^2.*Y.^2*(S_v4)^2)/(4*Z^2)} \\
& - \frac{(9*S^2.*Y.^2*(S_v4)^2)/(4*\exp(6*Z)*Z^2)}{(9*S^2.*Y.^2*(S_v4)^2)/(4*\exp(6*Z)*Z^2)} - \frac{(6*S^2.*Y.^2*(S_v4)^2)/(exp(5*Z)*Z^2)}{(6*S^2.*Y.^2*(S_v4)^2)/(exp(5*Z)*Z^2)}
\end{aligned}$$

$$\begin{aligned}
& + \frac{(31*S^2.*Y.^2*(S_v4)^2)/(4*exp(4*Z)*Z^2)}{} - \frac{(8*S^2.*Y.^2*(S_v4)^2)/(exp(3*Z)*Z^2)}{} + \\
& (23*S^2.*Y.^2*(S_v4)^2)/(4*exp(2*Z)*Z^2) - \frac{(2*S^2.*Y.^2*(S_v4)^2)/(exp(Z)*Z^2)}{\dots} \\
& - \frac{(9*exp(-5*Z - Y.*Z)*S^2.*Y.^2*(S_v4)^2)/(4*Z^2)}{} + \frac{(6*exp(-4*Z - Y.*Z)*S^2.*Y.^2*(S_v4)^2)/Z^2}{\dots} \\
& - \frac{(11*exp(-3*Z - Y.*Z)*S^2.*Y.^2*(S_v4)^2)/(2*Z^2)}{\dots} \\
& + \frac{(2*exp(-2*Z - Y.*Z)*S^2.*Y.^2*(S_v4)^2)/Z^2}{\dots} - \frac{(exp(-Z - Y.*Z)*S^2.*Y.^2*(S_v4)^2)/(4*Z^2)}{} + \\
& (9*S^2*(S_v4)^2)/(2*exp(5*Z)*Z) - \frac{(S^2*(S_v4)^2)/(exp(4*Z)*Z)}{\dots} \\
& + \frac{(25*S^2*(S_v4)^2)/(4*exp(3*Z)*Z)}{} - \frac{(3*S^2*(S_v4)^2)/(exp(2*Z)*Z)}{} + \\
& (3*S^2*(S_v4)^2)/(4*exp(Z)*Z) + \frac{(3*exp(-3*Z - 2.*Y.*Z)*S^2*(S_v4)^2)/(4*Z)}{\dots} \\
& + \frac{(3*exp(-Z - 2.*Y.*Z)*S^2*(S_v4)^2)/(4*Z)}{} + \frac{(3*exp(-4*Z - Y.*Z)*S^2*(S_v4)^2)/Z}{\dots} - \frac{(2*exp(-3*Z - Y.*Z)*S^2*(S_v4)^2)/Z}{\dots} \\
& + \frac{(2*exp(-2*Z - Y.*Z)*S^2*(S_v4)^2)/Z}{\dots} - \frac{(exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v4)^2)/Z}{\dots} - \frac{(2*exp(-2*Z - Y.*Z)*S^2.*Y.(S_v4)^2)/Z}{\dots} \\
& - \frac{(7*S^2.*Y.(S_v4)^2)/(4*exp(Z)*Z)}{} - \frac{(exp(-Z - 2.*Y.*Z)*S^2.*Y.(S_v4)^2)/Z}{\dots} - \frac{(2*exp(-2*Z - Y.*Z)*S^2.*Y.(S_v4)^2)/Z}{\dots} \\
& - \frac{(13*S^2.*Y.^2*(S_v4)^2)/(exp(4*Z)*Z)}{} + \frac{(41*S^2.*Y.^2*(S_v4)^2)/(4*exp(3*Z)*Z)}{} - \\
& (6*S^2.*Y.^2*(S_v4)^2)/(exp(2*Z)*Z) + \frac{(5*S^2.*Y.^2*(S_v4)^2)/(4*exp(Z)*Z)}{\dots} \\
& + \frac{(3*exp(-3*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v4)^2)/(4*Z)}{} - \frac{(exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v4)^2)/Z}{\dots} \\
& + \frac{(exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v4)^2)/(4*Z)}{\dots} - \frac{(9*S^2.*Y.^3*(S_v4)^2)/(4*exp(5*Z)*Z)}{} + \frac{(6*S^2.*Y.^3*(S_v4)^2)/(exp(4*Z)*Z)}{} - \\
& (11*S^2.*Y.^3*(S_v4)^2)/(2*exp(3*Z)*Z) + \frac{(2*S^2.*Y.^3*(S_v4)^2)/(exp(2*Z)*Z)}{\dots} - \frac{(S^2.*Y.^3*(S_v4)^2)/(4*exp(Z)*Z)}{} - \\
& (3*S^2*Z*(S_v4)^2)/(4*exp(3*Z)) + \frac{(S^2.*Y.^2*(S_v4)^2)/(exp(3*Z))}{\dots} + \frac{(S^2.*Y.^2*(S_v4)^2)/(exp(3*Z))}{\dots} \\
& + \frac{(S^2.*Y.^2*Z*(S_v4)^2)/(exp(4*Z))}{\dots} + \frac{(S^2.*Y.^2*Z*(S_v4)^2)/(2*exp(3*Z))}{\dots} - \frac{(S^2.*Y.^3*Z*(S_v4)^2)/(exp(3*Z))}{\dots} + \\
& (3*S^2.*Y.^4*Z*(S_v4)^2)/(4*exp(5*Z)) - \frac{(S^2.*Y.^4*Z*(S_v4)^2)/(exp(4*Z))}{\dots} + \frac{(S^2.*Y.^4*Z*(S_v4)^2)/(4*exp(3*Z))}{\dots} + \frac{(S^2.*Y.^4*Z*(S_v4)^2)/(2*exp(4*Z))}{\dots} \\
& (S^2.*Y.^4*Z*(S_v4)^2)/(4*exp(4*Z)) + \frac{(S^2.*Y.^4*Z*(S_v4)^2)/(2*exp(4*Z))}{\dots} + \frac{(S^2.*Y.^4*Z*(S_v4)^2)/(4*exp(4*Z))}{\dots} \\
\end{aligned}$$

Ns4=Nf+Nc+Ny4;  
Phi4=Nf./[Nc+Ny4];  
Be4=1./[1+Phi4];  
Gf4=Nf./Ns4;  
Gh4=[Nc+Ny4]./Ns4;  
Nh4=Nc+Ny4;

$$\begin{aligned}
S_v5 &= 5; \\
Ny5 &= 1 - exp(-2*Z) + exp(-Z - Y.*Z) - \frac{(2*S)/exp(2*Z)}{} + \frac{2*exp(-Z - Y.*Z)*S}{S^2/exp(2*Z)} + exp(-Z - Y.*Z)*S^2 - 2.*Y + Y.^2 + Y.^2/exp(2*Z) - exp(-Z - Y.*Z).*Y.^2 \dots \\
& + \frac{(2*S.*Y.^2)/exp(2*Z)}{} - \frac{2*exp(-Z - Y.*Z)*S.*Y.^2}{(S^2.*Y.^2)/exp(2*Z)} + \frac{(S^2.*Y.^2)/exp(2*Z)}{} - \frac{exp(-Z - Y.*Z)*S^2.*Y.^2}{(S^2.*Y.^2)/exp(2*Z)} + \frac{1/(exp(2*Z)*Z^2)}{} \dots \\
& - \frac{(2*exp(-Z - Y.*Z))/Z^2}{(2*S)/(exp(2*Z)*Z^2)} + \frac{(2*S)/(exp(2*Z)*Z^2)}{} + \frac{(2*S)/(exp(2.*Y.*Z)*Z^2)}{} - \frac{(4*exp(-Z - Y.*Z)*S)/Z^2}{(2*S)/(exp(2*Z)*Z^2)} + \frac{S^2/(exp(2.*Y.*Z)*Z^2)}{} \dots \\
& - \frac{(2*exp(-Z - Y.*Z)*S^2)/Z^2}{(2*S)/(exp(Y.*Z)*Z)} + \frac{2/(exp(Z)*Z)}{} - \frac{2.0/(exp(Y.*Z)*Z)}{} + \frac{(2*S)/(exp(Z)*Z)}{} - \frac{(2*S)/(exp(Y.*Z)*Z)}{} \dots \\
& - \frac{(2*S.*Y)/(exp(Z)*Z)}{} + \frac{(2*S.*Y)/(exp(Y.*Z)*Z)}{} - \frac{Z/exp(Z)}{} - \frac{(S*Z)/exp(Z)}{} + \frac{(Y.*Z)/exp(Z)}{} + \frac{(S.*Y.*Z)/exp(Z)}{} + \frac{(Y.^2*Z)/exp(Z)}{} + \frac{(S.*Y.^2*Z)/exp(Z)}{} - \frac{(Y.^3*Z)/exp(Z)}{} \dots \\
& - \frac{(S.*Y.^3*Z)/exp(Z)}{} + \frac{Z^2/(4*exp(2*Z))}{(S*Z^2)/(2*exp(2*Z))} + \frac{(S*Z^2)/(2*exp(2*Z))}{(S^2*Z^2)/(4*exp(2*Z))} + \frac{(S^2*Z^2)/(4*exp(2*Z))}{(S.^2*Y.^2*Z^2)/exp(2*Z)} - \frac{(S.^2*Y.^2*Z^2)/exp(2*Z)}{(Y.^2*Z^2)/(2*exp(2*Z))} - \frac{(S.^2*Y.^2*Z^2)/exp(2*Z)}{(S.^2*Y.^2*Z^2)/(2*exp(2*Z))} \dots \\
& - \frac{(S^2.*Y.^2*Z^2)/(2*exp(2*Z))}{(S.^2*Y.^2*Z^2)/(4*exp(2*Z))} + \frac{(Y.^4*Z^2)/(4*exp(2*Z))}{(7*S^2*(S_v5))/(2*exp(3*Z))} + \frac{(S.*Y.^4*Z^2)/(2*exp(2*Z))}{(S^2.*Y.^4*Z^2)/(4*exp(2*Z))} + \frac{(S^2.*Y.^4*Z^2)/(4*exp(2*Z))}{(5*S^2*(S_v5))/(exp(3*Z))} + \frac{(5*S^2*(S_v5))/(exp(3*Z))}{(2*S^2*(S_v5))/exp(2*Z)} - \frac{(2*S^2*(S_v5))/exp(2*Z)}{(S^2*(S_v5))/(exp(2*Z))} \dots \\
& - \frac{(exp(-Z - 2.*Y.*Z)*S^2*(S_v5))/2}{(2*S.*Y.(S_v5))/exp(2*Z)} - \frac{(2*S.*Y.(S_v5))/exp(2*Z)}{(3*S.*Y.(S_v5))/exp(Z)} + \frac{(3*S.*Y.(S_v5))/exp(Z)}{(3*S^2.*Y.(S_v5))/(2*exp(3*Z))} - \frac{(3*S^2.*Y.(S_v5))/(2*exp(3*Z))}{(2*S^2.*Y.(S_v5))/exp(2*Z)} \dots
\end{aligned}$$

$$\begin{aligned}
& + (S^2 * Y * (S_v5)) / (2 * \exp(Z)) + (13 * S * Y^2 * (S_v5)) / (2 * \exp(3 * Z)) - (4 * S * Y^2 * (S_v5)) / \exp(2 * Z) + \\
& (3 * S * Y^2 * (S_v5)) / \exp(Z) + (\exp(-Z - 2 * Y * Z) * S * Y^2 * (S_v5)) / 2 \dots \\
& + (5 * S^2 * Y^2 * (S_v5)) / \exp(3 * Z) - (2 * S^2 * Y^2 * (S_v5)) / \exp(2 * Z) + (S^2 * Y^2 * (S_v5)) / (2 * \exp(Z)) \\
& + (\exp(-Z - 2 * Y * Z) * S^2 * Y^2 * (S_v5)) / 2 - (3 * S * Y^3 * (S_v5)) / \exp(3 * Z) \dots \\
& + (4 * S * Y^3 * (S_v5)) / \exp(2 * Z) - (S * Y^3 * (S_v5)) / \exp(Z) - (3 * S^2 * Y^3 * (S_v5)) / (2 * \exp(3 * Z)) + \\
& (2 * S^2 * Y^3 * (S_v5)) / \exp(2 * Z) - (S^2 * Y^3 * (S_v5)) / (2 * \exp(Z)) \dots \\
& + (3 * S * (S_v5)) / (\exp(4 * Z) * Z^3) - (4 * S * (S_v5)) / (\exp(3 * Z) * Z^3) + (S * (S_v5)) / (\exp(2 * Z) * Z^3) + \\
& (S * (S_v5)) / (\exp(2 * Y * Z) * Z^3) + (3 * \exp(-2 * Z - 2 * Y * Z) * S * (S_v5)) / Z^3 \dots \\
& - (4 * \exp(-Z - 2 * Y * Z) * S * (S_v5)) / Z^3 - (6 * \exp(-3 * Z - Y * Z) * S * (S_v5)) / Z^3 + (8 * \exp(-2 * Z - \\
& Y * Z) * S * (S_v5)) / Z^3 - (2 * \exp(-Z - Y * Z) * S * (S_v5)) / Z^3 \dots \\
& + (3 * S^2 * (S_v5)) / (\exp(4 * Z) * Z^3) - (4 * S^2 * (S_v5)) / (\exp(3 * Z) * Z^3) + (S^2 * (S_v5)) / (\exp(2 * Z) * Z^3) + \\
& (S^2 * (S_v5)) / (\exp(2 * Y * Z) * Z^3) + (3 * \exp(-2 * Z - 2 * Y * Z) * S^2 * (S_v5)) / Z^3 \dots \\
& - (4 * \exp(-Z - 2 * Y * Z) * S^2 * (S_v5)) / Z^3 - (6 * \exp(-3 * Z - Y * Z) * S^2 * (S_v5)) / Z^3 + (8 * \exp(-2 * Z - \\
& Y * Z) * S^2 * (S_v5)) / Z^3 - (2 * \exp(-Z - Y * Z) * S^2 * (S_v5)) / Z^3 \dots \\
& + (11 * S * (S_v5)) / (\exp(3 * Z) * Z^2) - (8 * S * (S_v5)) / (\exp(2 * Z) * Z^2) + (2 * S * (S_v5)) / (\exp(Z) * Z^2) - \\
& (S * (S_v5)) / (\exp(3 * Y * Z) * Z^2) - (2 * S * (S_v5)) / (\exp(Y * Z) * Z^2) \dots \\
& - (\exp(-Z - 2 * Y * Z) * S * (S_v5)) / Z^2 - (9 * \exp(-2 * Z - Y * Z) * S * (S_v5)) / Z^2 + (8 * \exp(-Z - \\
& Y * Z) * S * (S_v5)) / Z^2 + (8 * S^2 * (S_v5)) / (\exp(3 * Z) * Z^2); \dots \\
& - (4 * S^2 * (S_v5)) / (\exp(2 * Z) * Z^2) + (S^2 * (S_v5)) / (\exp(Z) * Z^2) - (S^2 * (S_v5)) / (\exp(3 * Y * Z) * Z^2) - \\
& (S^2 * (S_v5)) / (\exp(Y * Z) * Z^2) - (\exp(-Z - 2 * Y * Z) * S^2 * (S_v5)) / Z^2 \dots \\
& - (6 * \exp(-2 * Z - Y * Z) * S^2 * (S_v5)) / Z^2 + (4 * \exp(-Z - Y * Z) * S^2 * (S_v5)) / Z^2 - \\
& (6 * S * Y * (S_v5)) / (\exp(3 * Z) * Z^2) + (8 * S * Y * (S_v5)) / (\exp(2 * Z) * Z^2) \dots \\
& - (2 * S * Y * (S_v5)) / (\exp(Z) * Z^2) + (2 * S * Y * (S_v5)) / (\exp(Y * Z) * Z^2) + (6 * \exp(-2 * Z - \\
& Y * Z) * S * Y * (S_v5)) / Z^2 - (8 * \exp(-Z - Y * Z) * S * Y * (S_v5)) / Z^2 \dots \\
& - (3 * S^2 * Y * (S_v5)) / (\exp(3 * Z) * Z^2) + (4 * S^2 * Y * (S_v5)) / (\exp(2 * Z) * Z^2) \dots \\
& (S^2 * Y * (S_v5)) / (\exp(Z) * Z^2) + (S^2 * Y * (S_v5)) / (\exp(Y * Z) * Z^2) \dots \\
& + (3 * \exp(-2 * Z - Y * Z) * S^2 * Y * (S_v5)) / Z^2 - (4 * \exp(-Z - Y * Z) * S^2 * Y * (S_v5)) / Z^2 + (S * (S_v5)) / Z \\
& + (2 * S * (S_v5)) / (\exp(3 * Z) * Z) + (9 * S * (S_v5)) / (\exp(2 * Z) * Z) \dots \\
& - (4 * S * (S_v5)) / (\exp(Z) * Z) + (S * (S_v5)) / (\exp(2 * Y * Z) * Z) - (2 * \exp(-2 * Z - Y * Z) * S * (S_v5)) / Z \\
& + (\exp(-Z - Y * Z) * S * (S_v5)) / Z + (2 * S^2 * (S_v5)) / (\exp(3 * Z) * Z) \dots \\
& + (S^2 * (S_v5)) / (\exp(2 * Z) * Z) - (2 * \exp(-2 * Z - Y * Z) * S^2 * (S_v5)) / Z - (\exp(-Z - Y * Z) * S^2 * (S_v5)) / Z \\
& - (2 * S * Y * (S_v5)) / Z - (13 * S * Y * (S_v5)) / (\exp(2 * Z) * Z) \dots \\
& + (8 * S * Y * (S_v5)) / (\exp(Z) * Z) - (S * Y * (S_v5)) / (\exp(2 * Y * Z) * Z) \dots \\
& (2 * S^2 * Y * (S_v5)) / (\exp(2 * Z) * Z) + (2 * \exp(-Z - Y * Z) * S^2 * Y * (S_v5)) / Z + (S * Y^2 * (S_v5)) / Z \dots \\
& + (3 * S * Y^2 * (S_v5)) / (\exp(4 * Z) * Z) - (4 * S * Y^2 * (S_v5)) / (\exp(3 * Z) * Z) \dots \\
& (4 * S * Y^2 * (S_v5)) / (\exp(2 * Z) * Z) - (4 * S * Y^2 * (S_v5)) / (\exp(Z) * Z) \dots \\
& - (3 * \exp(-3 * Z - Y * Z) * S * Y^2 * (S_v5)) / Z + (4 * \exp(-2 * Z - Y * Z) * S * Y^2 * (S_v5)) / Z - (\exp(-Z - \\
& Y * Z) * S * Y^2 * (S_v5)) / Z + (3 * S^2 * Y^2 * (S_v5)) / (\exp(4 * Z) * Z) \dots \\
& - (4 * S^2 * Y^2 * (S_v5)) / (\exp(3 * Z) * Z) + (S^2 * Y^2 * (S_v5)) / (\exp(2 * Z) * Z) - (3 * \exp(-3 * Z - \\
& Y * Z) * S^2 * Y^2 * (S_v5)) / Z + (4 * \exp(-2 * Z - Y * Z) * S^2 * Y^2 * (S_v5)) / Z \dots \\
& - (\exp(-Z - Y * Z) * S^2 * Y^2 * (S_v5)) / Z - (3 * S * Z * (S_v5)) / (4 * \exp(4 * Z)) - (7 * S * Z * (S_v5)) / (4 * \exp(2 * Z)) \\
& - (3 * S^2 * Z * (S_v5)) / (4 * \exp(4 * Z)) - (3 * S^2 * Z * (S_v5)) / (4 * \exp(2 * Z)) \dots \\
& + (2 * S * Y * Z * (S_v5)) / \exp(2 * Z) + (S^2 * Y * Z * (S_v5)) / \exp(2 * Z) + (S * Y^2 * Z * (S_v5)) / \exp(3 * Z) + \\
& (3 * S * Y^2 * Z * (S_v5)) / (2 * \exp(2 * Z)) + (S^2 * Y^2 * Z * (S_v5)) / \exp(3 * Z) \dots \\
& + (S^2 * Y^2 * Z * (S_v5)) / (2 * \exp(2 * Z)) - (2 * S * Y^3 * Z * (S_v5)) / \exp(2 * Z) \dots \\
& (S^2 * Y^3 * Z * (S_v5)) / \exp(2 * Z) + (3 * S * Y^4 * Z * (S_v5)) / (4 * \exp(4 * Z)) - (S * Y^4 * Z * (S_v5)) / \exp(3 * Z) \\
& \dots \\
& + (S * Y^4 * Z * (S_v5)) / (4 * \exp(2 * Z)) + (3 * S^2 * Y^4 * Z * (S_v5)) / (4 * \exp(4 * Z)) \dots \\
& (S^2 * Y^4 * Z * (S_v5)) / \exp(3 * Z) + (S^2 * Y^4 * Z * (S_v5)) / (4 * \exp(2 * Z)) + (S * Z^2 * (S_v5)) / (2 * \exp(3 * Z)) \\
& \dots \\
& + (S^2 * Z^2 * (S_v5)) / (2 * \exp(3 * Z)) - (S * Y^2 * Z^2 * (S_v5)) / \exp(3 * Z) \dots \\
& (S^2 * Y^2 * Z^2 * (S_v5)) / \exp(3 * Z) + (S * Y^4 * Z^2 * (S_v5)) / (2 * \exp(3 * Z)) \dots \\
& + (S^2 * Y^4 * Z^2 * (S_v5)) / (2 * \exp(3 * Z)) + (9 * S^2 * (S_v5)^2) / (16 * \exp(6 * Z)) \dots \\
& (23 * S^2 * (S_v5)^2) / (8 * \exp(4 * Z)) + (2 * S^2 * (S_v5)^2) / \exp(3 * Z) + (S^2 * (S_v5)^2) / (16 * \exp(2 * Z)) \dots
\end{aligned}$$

$$\begin{aligned}
& - (\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v5)^2/2 - \exp(-3*Z) - Y.*Z)*S^2*(S_v5)^2 \\
& -(2*S^2.*Y.(S_v5)^2)/\exp(3*Z) - (S^2.*Y.(S_v5)^2)/\exp(2*Z) + (9*S^2.*Y.^2*(S_v5)^2)/(8*\exp(6*Z)) \\
& \dots \\
& - (3*S^2.*Y.^2*(S_v5)^2)/(2*\exp(5*Z)) + (11*S^2.*Y.^2*(S_v5)^2)/(2*\exp(4*Z)) \\
& (7*S^2.*Y.^2*(S_v5)^2)/(2*\exp(3*Z)) + (15*S^2.*Y.^2*(S_v5)^2)/(8*\exp(2*Z)) \dots \\
& + (\exp(-2*Z) - 2.*Y.*Z)*S^2.*Y.^2*(S_v5)^2/2 + \exp(-3*Z) - Y.*Z)*S^2.*Y.^2*(S_v5)^2 \\
& (3*S^2.*Y.^3*(S_v5)^2)/\exp(4*Z) + (4*S^2.*Y.^3*(S_v5)^2)/\exp(3*Z) \dots \\
& - (S^2.*Y.^3*(S_v5)^2)/\exp(2*Z) + (9*S^2.*Y.^4*(S_v5)^2)/(16*\exp(6*Z)) \\
& (3*S^2.*Y.^4*(S_v5)^2)/(2*\exp(5*Z)) + (11*S^2.*Y.^4*(S_v5)^2)/(8*\exp(4*Z)) \dots \\
& - (S^2.*Y.^4*(S_v5)^2)/(2*\exp(3*Z)) + (S^2.*Y.^4*(S_v5)^2)/(16*\exp(2*Z)) \\
& (9*S^2*(S_v5)^2)/(4*\exp(6*Z)*Z^4) - (6*S^2*(S_v5)^2)/(\exp(5*Z)*Z^4) \dots \\
& + (11*S^2*(S_v5)^2)/(2*\exp(4*Z)*Z^4) - (2*S^2*(S_v5)^2)/(\exp(3*Z)*Z^4) \\
& (S^2*(S_v5)^2)/(4*\exp(2*Z)*Z^4) + (S^2*(S_v5)^2)./(4*\exp(2.*Y.*Z)*Z^4) \dots \\
& + (9*\exp(-4*Z) - 2.*Y.*Z)*S^2*(S_v5)^2)/(4*Z^4) - (6*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v5)^2/Z^4 + \\
& (11*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v5)^2)/(2*Z^4) \dots \\
& - (2*\exp(-Z) - 2.*Y.*Z)*S^2*(S_v5)^2)/Z^4 - (9*\exp(-5*Z) - Y.*Z)*S^2*(S_v5)^2)/(2*Z^4) + (12*\exp(- \\
& 4*Z) - Y.*Z)*S^2*(S_v5)^2)/Z^4 - (11*\exp(-3*Z) - Y.*Z)*S^2*(S_v5)^2)/Z^4 \dots \\
& + (4*\exp(-2*Z) - Y.*Z)*S^2*(S_v5)^2)/Z^4 - (\exp(-Z) - Y.*Z)*S^2*(S_v5)^2)/(2*Z^4) \\
& (12*S^2*(S_v5)^2)/(\exp(5*Z)*Z^3) - (22*S^2*(S_v5)^2)/(\exp(4*Z)*Z^3) \dots \\
& + (27*S^2*(S_v5)^2)/(2*\exp(3*Z)*Z^3) - (4*S^2*(S_v5)^2)/(\exp(2*Z)*Z^3) \\
& (S^2*(S_v5)^2)/(2*\exp(Z)*Z^3) - (S^2*(S_v5)^2)./(2*\exp(3.*Y.*Z)*Z^3) \dots \\
& - (S^2*(S_v5)^2)./(2*\exp(Y.*Z)*Z^3) - (3*\exp(-2*Z) - 3.*Y.*Z)*S^2*(S_v5)^2)/(2*Z^3) + (2*\exp(-Z) - \\
& 3.*Y.*Z)*S^2*(S_v5)^2)/Z^3 - (3*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v5)^2)/(2*Z^3) \dots \\
& + (2*\exp(-2*Z) - 2.*Y.*Z)*S^2*(S_v5)^2)/Z^3 - (\exp(-Z) - 2.*Y.*Z)*S^2*(S_v5)^2)/(2*Z^3) - (9*\exp(- \\
& 4*Z) - Y.*Z)*S^2*(S_v5)^2)/Z^3 + (18*\exp(-3*Z) - Y.*Z)*S^2*(S_v5)^2)/Z^3 \dots \\
& - (25*\exp(-2*Z) - Y.*Z)*S^2*(S_v5)^2)/(2*Z^3) + (4*\exp(-Z) - Y.*Z)*S^2*(S_v5)^2)/Z^3 - \\
& (9*S^2.*Y.(S_v5)^2)/(2*\exp(5*Z)*Z^3) + (12*S^2.*Y.(S_v5)^2)/(\exp(4*Z)*Z^3) \dots \\
& - (11*S^2.*Y.(S_v5)^2)/(exp(3*Z)*Z^3) + (4*S^2.*Y.(S_v5)^2)/(\exp(2*Z)*Z^3) \\
& (S^2.*Y.(S_v5)^2)/(2*\exp(Z)*Z^3) + (S^2.*Y.(S_v5)^2)/(2*\exp(Y.*Z)*Z^3) \dots \\
& + (9*\exp(-4*Z) - Y.*Z)*S^2.*Y.(S_v5)^2)/(2*Z^3) - (12*\exp(-3*Z) - Y.*Z)*S^2.*Y.(S_v5)^2)/Z^3 + \\
& (11*\exp(-2*Z) - Y.*Z)*S^2.*Y.(S_v5)^2)/Z^3 \dots \\
& - (4*\exp(-Z) - Y.*Z)*S^2.*Y.(S_v5)^2)/Z^3 + (S^2*(S_v5)^2)/(4*Z^2) \\
& (9*S^2*(S_v5)^2)/(4*\exp(6*Z)*Z^2) - (3*S^2*(S_v5)^2)/(\exp(5*Z)*Z^2) \\
& (19*S^2*(S_v5)^2)/(exp(4*Z)*Z^2) \dots \\
& - (19*S^2*(S_v5)^2)/(exp(3*Z)*Z^2) + (35*S^2*(S_v5)^2)/(4*\exp(2*Z)*Z^2) \\
& (2*S^2*(S_v5)^2)/(\exp(Z)*Z^2) + (S^2*(S_v5)^2)./(4*\exp(4.*Y.*Z)*Z^2) \dots \\
& + (S^2*(S_v5)^2)./(2*\exp(2.*Y.*Z)*Z^2) + (\exp(-Z) - 3.*Y.*Z)*S^2*(S_v5)^2)/Z^2 + (5*\exp(-2*Z) - \\
& 2.*Y.*Z)*S^2*(S_v5)^2)/Z^2 - (2*\exp(-Z) - 2.*Y.*Z)*S^2*(S_v5)^2)/Z^2 \dots \\
& - (9*\exp(-5*Z) - Y.*Z)*S^2*(S_v5)^2)/(4*Z^2) + (3*\exp(-4*Z) - Y.*Z)*S^2*(S_v5)^2)/Z^2 + (5*\exp(- \\
& 3*Z) - Y.*Z)*S^2*(S_v5)^2)/Z^2 - (\exp(-2*Z) - Y.*Z)*S^2*(S_v5)^2)/Z^2 \dots \\
& + (\exp(-Z) - Y.*Z)*S^2*(S_v5)^2)/(4*Z^2) - (S^2.*Y.(S_v5)^2)/(2*Z^2) \\
& (15*S^2.*Y.(S_v5)^2)/(exp(4*Z)*Z^2) + (26*S^2.*Y.(S_v5)^2)/(\exp(3*Z)*Z^2) \dots \\
& - (29*S^2.*Y.(S_v5)^2)/(2*\exp(2*Z)*Z^2) + (4*S^2.*Y.(S_v5)^2)/(\exp(Z)*Z^2) \\
& (S^2.*Y.(S_v5)^2)./(2*\exp(2.*Y.*Z)*Z^2) - (3*\exp(-2*Z) - 2.*Y.*Z)*S^2.*Y.(S_v5)^2)/(2*Z^2) \dots \\
& + (2*\exp(-Z) - 2.*Y.*Z)*S^2.*Y.(S_v5)^2)/Z^2 + (S^2.*Y.^2*(S_v5)^2)/(4*Z^2) \\
& (9*S^2.*Y.^2*(S_v5)^2)/(4*\exp(6*Z)*Z^2) - (6*S^2.*Y.^2*(S_v5)^2)/(\exp(5*Z)*Z^2) \dots \\
& + (31*S^2.*Y.^2*(S_v5)^2)/(4*\exp(4*Z)*Z^2) - (8*S^2.*Y.^2*(S_v5)^2)/(\exp(3*Z)*Z^2) \\
& (23*S^2.*Y.^2*(S_v5)^2)/(4*\exp(2*Z)*Z^2) - (2*S^2.*Y.^2*(S_v5)^2)/(\exp(Z)*Z^2) \dots \\
& - (9*\exp(-5*Z) - Y.*Z)*S^2.*Y.^2*(S_v5)^2)/(4*Z^2) + (6*\exp(-4*Z) - Y.*Z)*S^2.*Y.^2*(S_v5)^2)/Z^2 \\
& - (11*\exp(-3*Z) - Y.*Z)*S^2.*Y.^2*(S_v5)^2)/(2*Z^2) \dots \\
& + (2*\exp(-2*Z) - Y.*Z)*S^2.*Y.^2*(S_v5)^2)/Z^2 - (\exp(-Z) - Y.*Z)*S^2.*Y.^2*(S_v5)^2)/(4*Z^2) + \\
& (9*S^2*(S_v5)^2)/(2*\exp(5*Z)*Z) - (S^2*(S_v5)^2)/(\exp(4*Z)*Z) \dots \\
& + (25*S^2*(S_v5)^2)/(4*\exp(3*Z)*Z) - (3*S^2*(S_v5)^2)/(\exp(2*Z)*Z) \\
& (3*S^2*(S_v5)^2)/(4*\exp(Z)*Z) + (3*\exp(-3*Z) - 2.*Y.*Z)*S^2*(S_v5)^2)/(4*Z) \\
& + (3*\exp(-Z) - 2.*Y.*Z)*S^2*(S_v5)^2)/(4*Z) + (3*\exp(-4*Z) - Y.*Z)*S^2*(S_v5)^2)/Z - (2*\exp(-3*Z) - \\
& Y.*Z)*S^2*(S_v5)^2)/Z + (2*\exp(-2*Z) - Y.*Z)*S^2*(S_v5)^2)/Z \dots
\end{aligned}$$

$$\begin{aligned}
& - \frac{(9*S^2.*Y.*(S_v5)^2)/(4*exp(5*Z)*Z)}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} + \frac{(3*S^2.*Y.*(S_v5)^2)/(exp(4*Z)*Z)}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} \\
& - \frac{(7*S^2.*Y.*(S_v5)^2)/(4*exp(Z)*Z)}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} - \frac{(exp(-Z - 2.*Y.*Z)*S^2.*Y.*(S_v5)^2)/Z}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} - \frac{(2*exp(-2*Z - Y.*Z)*S^2.*Y.*(S_v5)^2)/Z}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} \\
& - \frac{(13*S^2.*Y.^2*(S_v5)^2)/(exp(4*Z)*Z)}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} + \frac{(41*S^2.*Y.^2*(S_v5)^2)/(4*exp(3*Z)*Z)}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} \\
& - \frac{(6*S^2.*Y.^2*(S_v5)^2)/(exp(2*Z)*Z)}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} + \frac{(5*S^2.*Y.^2*(S_v5)^2)/(4*exp(Z)*Z)}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} \\
& + \frac{(3*exp(-3*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v5)^2)/(4*Z)}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} - \frac{(exp(-2*Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v5)^2)/(4*Z)}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} \\
& + \frac{(exp(-Z - 2.*Y.*Z)*S^2.*Y.^2*(S_v5)^2)/(4*Z)}{(11*S^2.*Y.*(S_v5)^2)/(exp(3*Z)*Z) + (7*S^2.*Y.*(S_v5)^2)/(exp(2*Z)*Z)} \\
& - \frac{(9*S^2.*Y.^3*(S_v5)^2)/(4*exp(5*Z)*Z)}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} + \frac{(6*S^2.*Y.^3*(S_v5)^2)/(exp(4*Z)*Z)}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} \\
& - \frac{(S^2.*Y.^3*(S_v5)^2)/(4*exp(Z)*Z)}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} - \frac{(3*S^2.*Z*(S_v5)^2)/(4*exp(5*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} \\
& - \frac{(3*S^2.*Z*(S_v5)^2)/(4*exp(3*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} + \frac{(S^2.*Y.^2*(S_v5)^2)/(exp(3*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} \\
& + \frac{(S^2.*Y.^2*(S_v5)^2)/(exp(4*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} - \frac{(S^2.*Y.^3*Z*(S_v5)^2)/(exp(3*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} \\
& - \frac{(3*S^2.*Y.^4*Z*(S_v5)^2)/(4*exp(5*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} - \frac{(S^2.*Y.^4*Z*(S_v5)^2)/(exp(4*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} \\
& + \frac{(S^2.*Y.^4*Z*(S_v5)^2)/(4*exp(3*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} + \frac{(S^2.*Z^2*(S_v5)^2)/(4*exp(4*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} \\
& - \frac{(S^2.*Z^2*(S_v5)^2)/(2*exp(4*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)} + \frac{(S^2.*Z^2*(S_v5)^2)/(4*exp(4*Z))}{(11*S^2.*Y.^3*(S_v5)^2)/(2*exp(3*Z)*Z) + (2*S^2.*Y.^3*(S_v5)^2)/(exp(2*Z)*Z)};
\end{aligned}$$

```

Ns5=Nf+Nc+Ny5;
Phi5=Nf./[Nc+Ny5];
Be5=1./[1+Phi5];
Gf5=Nf./Ns5;
Gh5=[Nc+Ny5]./Ns5;
Nh5=Nc+Ny5;

```

```

plot(Y,Ns1,'b',Y,Ns2,'g',Y,Ns3,'r',Y,Ns4,'k',Y,Ns5,'m')

% plot(Y,Be1,'b',Y,Be2,'g',Y,Be3,'r',Y,Be4,'k',Y,Be5,'m')

% plot(Y,Phi1,'b',Y,Phi2,'g',Y,Phi3,'r',Y,Phi4,'k',Y,Phi5,'m')

% plot(Y,Gf1,'b',Y,Gf2,'g',Y,Gf3,'r',Y,Gf4,'k',Y,Gf5,'m')

% plot(Y,Gh1,'b',Y,Gh2,'g',Y,Gh3,'r',Y,Gh4,'k',Y,Gh5,'m')

% plot(Y,Nf1,'b',Y,Nf2,'g',Y,Nf3,'r',Y,Nf4,'k',Y,Nf5,'m')

% plot(Y,Nh1,'b',Y,Nh2,'g',Y,Nh3,'r',Y,Nh4,'k',Y,Nh5,'m')

% plot(Nh1,Nf1,'b',Nh2,Nf2,'g',Nh3,Nf3,'r',Nh4,Nf4,'k',Nh5,Nf5,'m')

```

PLOTOOLS ON

**2. PROGRAMS FOR  
CIRCULAR MICROTUBE**

## 2.1. Distribution of $N_s$ , $Be$ , $\Phi$ , $G_F$ , $G_R$ , $N_F$ and $N_H$ versus $R$ for a range of $Br$ and set of $S$ , $S_v$ , $Z$ & $Pe$

```

S=1; S_v=1; Z=1; Pe=10;
% S=5; S_v=0.75; Z=7.5; Pe=2;
% % % % S=2; S_v=1; Z=5; Pe=0.5;
% % % % S=25; S_v=15; Z=10; Pe=2.5;
% % % % S=20; S_v=2; Z=2.5; Pe=0.5;
% % % % S=10; S_v=25; Z=20; Pe=5;

q=1.86;
s=1;
Dh=250*10^-6;
R=0:0.005:1;

Nc=[1/Pe^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Nr=(R.^2*S.^2)/4 + (25.*R.^2*S.^2*(S_v))/(384*(1 + Z.^2/4 + Z.^4/64)^2)+ (R.^2.*R.^2*S.^2*S.^2*(S_v))/(4*(1 + Z.^2/4 + Z.^4/64)^2) - ...
(43.*R.^4*S.^2*Z.^2*(S_v))/(384*(1 + Z.^2/4 + Z.^4/64)^2)... + (5.*R.^5.*R.^2*Z.^2*Z.^3*(S_v))/(32*(1 + Z.^2/4 + Z.^4/64)^2) + (407.*R.^6*S.^2*Z.^4*(S_v))/(4096*(1 + Z.^2/4 + Z.^4/64)^2) + ...
(7.*R.^7.*R.^2*Z.^2*Z.^5*(S_v))/(768*(1 + Z.^2/4 + Z.^4/64)^2) + (539.*R.^8*S.^2*Z.^6*(S_v))/(4096*(1 + Z.^2/4 + Z.^4/64)^2) + ...
(85225.*R.^10*S.^2*Z.^8*(S_v))/(1572864*(1 + Z.^2/4 + Z.^4/64)^2) + (6487.*R.^12*S.^2*Z.^10*(S_v))/(393216*(1 + Z.^2/4 + Z.^4/64)^2) + ...
(17773.*R.^14*S.^2*Z.^12*(S_v))/(4194304*(1 + Z.^2/4 + Z.^4/64)^2) + (2011.*R.^16*S.^2*Z.^14*(S_v))/(2097152*(1 + Z.^2/4 + Z.^4/64)^2) + ...
(206775.*R.^18*S.^2*Z.^16*(S_v))/(1073741824*(1 + Z.^2/4 + Z.^4/64)^2) + (108275.*R.^20*S.^2*Z.^18*(S_v))/(3221225472*(1 + Z.^2/4 + Z.^4/64)^2) + ...
(512435.*R.^22*S.^2*Z.^20*(S_v))/(103079215104*(1 + Z.^2/4 + Z.^4/64)^2) + (21031.*R.^24*S.^2*Z.^22*(S_v))/(34359738368*(1 + Z.^2/4 + Z.^4/64)^2) + ...
(272987.*R.^26*S.^2*Z.^24*(S_v))/(4398046511104*(1 + Z.^2/4 + Z.^4/64)^2) + (11305.*R.^28*S.^2*Z.^26*(S_v))/(2199023255552*(1 + Z.^2/4 + Z.^4/64)^2) + ...
(24225.*R.^30*S.^2*Z.^28*(S_v))/(70368744177664*(1 + Z.^2/4 + Z.^4/64)^2) + (323.*R.^32*S.^2*Z.^30*(S_v))/(17592186044416*(1 + Z.^2/4 + Z.^4/64)^2) + ...
(27455.*R.^34*S.^2*Z.^32*(S_v))/(36028797018963968*(1 + Z.^2/4 + Z.^4/64)^2) + (855.*R.^36*S.^2*Z.^34*(S_v))/(36028797018963968*(1 + Z.^2/4 + Z.^4/64)^2) + ...
(1805.*R.^38*S.^2*Z.^36*(S_v))/(3458764513820540928*(1 + Z.^2/4 + Z.^4/64)^2) + (25.*R.^40*S.^2*Z.^38*(S_v))/(3458764513820540928*(1 + Z.^2/4 + Z.^4/64)^2) + ...
(7.*R.^42*S.^2*Z.^40*(S_v))/(147573952589676412928*(1 + Z.^2/4 + Z.^4/64)^2) + (625.*R.^2*S.^2*(S_v)^2)/(147456*(1 + Z.^2/4 + Z.^4/64)^4) + ...
(25.*R.^2.*R.^2*S.^2*(S_v)^2)/(768*(1 + Z.^2/4 + Z.^4/64)^4) + (R.^2.*R.^2*Z.^4*S.^2*(S_v)^2)/(16*(1 + Z.^2/4 + Z.^4/64)^4) - ...
(1075.*R.^4*S.^2*Z.^2*(S_v)^2)/(73728*(1 + Z.^2/4 + Z.^4/64)^4) - (43.*R.^4.*R.^2*Z.^2*S.^2*Z.^2*(S_v)^2)/(768*(1 + Z.^2/4 + Z.^4/64)^4) + ...
(125.*R.^5.*R.^2*Z.^2*Z.^3*(S_v)^2)/(6144*(1 + Z.^2/4 + Z.^4/64)^4) + (5.*R.^5.*R.^2*Z.^3*S.^2*Z.^3*(S_v)^2)/(64*(1 + Z.^2/4 + Z.^4/64)^4) + ...
(60109.*R.^6*S.^2*Z.^4*(S_v)^2)/(2359296*(1 + Z.^2/4 + Z.^4/64)^4) + (407.*R.^6.*R.^2*Z.^2*S.^2*Z.^4*(S_v)^2)/(8192*(1 + Z.^2/4 + Z.^4/64)^4) - ...
(4985.*R.^7.*R.^2*Z.^2*Z.^5*(S_v)^2)/(147456*(1 + Z.^2/4 + Z.^4/64)^4) + (7.*R.^7.*R.^2*Z.^3*S.^2*Z.^5*(S_v)^2)/(1536*(1 + Z.^2/4 + Z.^4/64)^4) - ...

```

$$\begin{aligned}
& (671.*R.^8*S^2*Z^6*(S_v)^2)/(131072*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (739.*R.^8.*R.*Z^2*S^2*Z^6*(S_v)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (17111.*R.^9.*R.*Z^2*S^2*Z^7*(S_v)^2)/(589824*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (3787661.*R.^10.*S^2*Z^8*(S_v)^2)/(301989888*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (31395.*R.^10.*R.*Z^2*S^2*Z^8*(S_v)^2)/(1048576*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (67529.*R.^11.*R.*Z^2*S^2*Z^9*(S_v)^2)/(1572864*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (1627151.*R.^12.*S^2*Z^10*(S_v)^2)/(100663296*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (19657.*R.^12.*R.*Z^2*S^2*Z^10*(S_v)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (486493.*R.^13.*R.*Z^2*S^2*Z^11*(S_v)^2)/(25165824*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (241027273.*R.^14.*S^2*Z^12*(S_v)^2)/(9663676416*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (17773.*R.^14.*R.*Z^2*S^2*Z^12*(S_v)^2)/(8388608*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (3710335.*R.^15.*R.*Z^2*S^2*Z^13*(S_v)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (53842355.*R.^16.*S^2*Z^14*(S_v)^2)/(3221225472*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (2011.*R.^16.*R.*Z^2*S^2*Z^14*(S_v)^2)/(4194304*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (981421.*R.^17.*R.*Z^2*S^2*Z^15*(S_v)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (19618549477.*R.^18.*S^2*Z^16*(S_v)^2)/(2473901162496*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (206775.*R.^18.*R.*Z^2*S^2*Z^16*(S_v)^2)/(2147483648*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (607051.*R.^19.*R.*Z^2*S^2*Z^17*(S_v)^2)/(1610612736*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (944668661.*R.^20.*S^2*Z^18*(S_v)^2)/(309237645312*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (108275.*R.^20.*R.*Z^2*S^2*Z^18*(S_v)^2)/(6442450944*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (4002553.*R.^21.*R.*Z^2*S^2*Z^19*(S_v)^2)/(51539607552*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (3348433219.*R.^22.*S^2*Z^20*(S_v)^2)/(3298534883328*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (512435.*R.^22.*R.*Z^2*S^2*Z^20*(S_v)^2)/(206158430208*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (5778425.*R.^23.*R.*Z^2*S^2*Z^21*(S_v)^2)/(412316860416*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (1484626111.*R.^24.*S^2*Z^22*(S_v)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (21031.*R.^24.*R.*Z^2*S^2*Z^22*(S_v)^2)/(68719476736*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (10718225.*R.^25.*R.*Z^2*S^2*Z^23*(S_v)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (33848465467.*R.^26.*S^2*Z^24*(S_v)^2)/(422212465065984*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (272987.*R.^26.*R.*Z^2*S^2*Z^24*(S_v)^2)/(8796093022208*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (11158205.*R.^27.*R.*Z^2*S^2*Z^25*(S_v)^2)/(39582418599936*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (24750045961.*R.^28.*S^2*Z^26*(S_v)^2)/(1266637395197952*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (11305.*R.^28.*R.*Z^2*S^2*Z^26*(S_v)^2)/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (6450277.*R.^29.*R.*Z^2*S^2*Z^27*(S_v)^2)/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (59064594011.*R.^30.*S^2*Z^28*(S_v)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (24225.*R.^30.*R.*Z^2*S^2*Z^28*(S_v)^2)/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (4624109.*R.^31.*R.*Z^2*S^2*Z^29*(S_v)^2)/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (36553306561.*R.^32.*S^2*Z^30*(S_v)^2)/(40532396646334464*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (323.*R.^32.*R.*Z^2*S^2*Z^30*(S_v)^2)/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (679915.*R.^33.*R.*Z^2*S^2*Z^31*(S_v)^2)/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (1189947216611.*R.^34.*S^2*Z^32*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (27455.*R.^34.*R.*Z^2*S^2*Z^32*(S_v)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (108205.*R.^35.*R.*Z^2*S^2*Z^33*(S_v)^2)/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (105030792781.*R.^36.*S^2*Z^34*(S_v)^2)/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (855.*R.^36.*R.*Z^2*S^2*Z^34*(S_v)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (990641.*R.^37.*R.*Z^2*S^2*Z^35*(S_v)^2)/(1729382256910270464*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (548568674633.*R.^38.*S^2*Z^36*(S_v)^2)/... \\
& (110680464442257309696*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (1805.*R.^38.*R.*Z^2*S^2*Z^36*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (294785.*R.^39.*R.*Z^2*S^2*Z^37*(S_v)^2)/(13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (10322387501.*R.^40.*S^2*Z^38*(S_v)^2)/... \\
& (13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (25.*R.^40.*R.*Z^2*S^2*Z^38*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (32965.*R.^41.*R.*Z^2*S^2*Z^39*(S_v)^2)/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (1462601471251.*R.^42.*S^2*Z^40*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (7.*R.^42.*R.*Z^2*S^2*Z^40*(S_v)^2)/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) ...
\end{aligned}$$

$$\begin{aligned}
& (15635.*R.^43.*R.^Z*S^2*Z^41*(S_v)^2)/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^44*S^2*Z^42*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3115.*R.^45.*R.^Z*S^2*Z^43*(S_v)^2)/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (2057042720599.*R.^46*S^2*Z^44*(S_v)^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& ... \\
& (49.*R.^47.*R.^Z*S^2*Z^45*(S_v)^2)/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^48*S^2*Z^46*(S_v)^2)/... \\
& (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5273670271697.*R.^50*S^2*Z^48*(S_v)^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (37823055319.*R.^52*S^2*Z^50*(S_v)^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (31266829573.*R.^54*S^2*Z^52*(S_v)^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (305764487.*R.^56*S^2*Z^54*(S_v)^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (155671821505.*R.^58*S^2*Z^56*(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (8605263625.*R.^60*S^2*Z^58*(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (4487015167.*R.^62*S^2*Z^60*(S_v)^2)/(3802951800684688204490109616128*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (64197131.*R.^64*S^2*Z^62*(S_v)^2)/(1267650600228229401496703205376*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (7366421503.*R.^66*S^2*Z^64*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (118374655.*R.^68*S^2*Z^66*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (103217975.*R.^70*S^2*Z^68*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (1169089.*R.^72*S^2*Z^70*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (16453715.*R.^74*S^2*Z^72*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (234365.*R.^76*S^2*Z^74*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (77905.*R.^78*S^2*Z^76*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (175.*R.^80*S^2*Z^78*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (49.*R.^82*S^2*Z^80*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z^{2/4} + Z^{4/64})^4);
\end{aligned}$$

```

Br1=0.2;
Nf1=Br1*[(1024.*R.^2.*Z^4 + 256.*R.^4.*Z^6 + 16.*R.^6.*Z^8)/(4096 + 2048*Z^2 + 384*Z^4 + 32*Z^6 + Z^8)];
Ns1=Nf1+Nc+Nr;
Phi1=Nf1./[Nc+Nr];
Be1=1./[1+Phi1];
Gf1=Nf1./Ns1;
Gr1=[Nr]./Ns1;

```

Br2=0.4;

```

Nf2=Br2*[(1024.*R.^2.*Z^4 + 256.*R.^4.*Z^6 + 16.*R.^6.*Z^8)/(4096 + 2048*Z^2 + 384*Z^4 +
32*Z^6 + Z^8)];
Ns2=Nf2+Nc+Nr;
Phi2=Nf2./[Nc+Nr];
Be2=1./[1+Phi2];
Gf2=Nf2./Ns2;
Gr2=[Nr]./Ns2;

Br3=0.6;
Nf3=Br3*[(1024.*R.^2.*Z^4 + 256.*R.^4.*Z^6 + 16.*R.^6.*Z^8)/(4096 + 2048*Z^2 + 384*Z^4 +
32*Z^6 + Z^8)];
Ns3=Nf3+Nc+Nr;
Phi3=Nf3./[Nc+Nr];
Be3=1./[1+Phi3];
Gf3=Nf3./Ns3;
Gr3=[Nr]./Ns3;

Br4=0.8;
Nf4=Br4*[(1024.*R.^2.*Z^4 + 256.*R.^4.*Z^6 + 16.*R.^6.*Z^8)/(4096 + 2048*Z^2 + 384*Z^4 +
32*Z^6 + Z^8)];
Ns4=Nf4+Nc+Nr;
Phi4=Nf4./[Nc+Nr];
Be4=1./[1+Phi4];
Gf4=Nf4./Ns4;
Gr4=[Nr]./Ns4;

Br5=1;
Nf5=Br5*[(1024.*R.^2.*Z^4 + 256.*R.^4.*Z^6 + 16.*R.^6.*Z^8)/(4096 + 2048*Z^2 + 384*Z^4 +
32*Z^6 + Z^8)];
Ns5=Nf5+Nc+Nr;
Phi5=Nf5./[Nc+Nr];
Be5=1./[1+Phi5];
Gf5=Nf5./Ns5;
Gr5=[Nr]./Ns5;

Nh=Nc+Nr;

plot(R,Ns1,'b',R,Ns2,'g',R,Ns3,'r',R,Ns4,'k',R,Ns5,'m')
% plot(R,Be1,'b',R,Be2,'g',R,Be3,'r',R,Be4,'k',R,Be5,'m')
% plot(R,Phi1,'b',R,Phi2,'g',R,Phi3,'r',R,Phi4,'k',R,Phi5,'m')
% plot(R,Gf1,'b',R,Gf2,'g',R,Gf3,'r',R,Gf4,'k',R,Gf5,'m')
% plot(R,Gr1,'b',R,Gr2,'g',R,Gr3,'r',R,Gr4,'k',R,Gr5,'m')
% plot(R,Nf1,'b',R,Nf2,'g',R,Nf3,'r',R,Nf4,'k',R,Nf5,'m')
% plot(R,Nh)

PLOTOOLS ON

```

**2.2. Distribution of  $N_s$ ,  $Be$ ,  $\Phi$ ,  $G_F$ ,  $G_R$ ,  $N_F$  and  $N_H$  versus  $Y$  for a range of  $Z$  and set of  $S$ ,  $S_v$ ,  $Br$  &  $Pe$**

```

S=1; S_v=1; Br=1; Pe=10;
% S=5; S_v=2; Br=0.5; Pe=2;

% % % % S=20; S_v=5; Br=0.2; Pe=0.5;
% % % % S=2; S_v=1; Br=0.8; Pe=0.5;
% % % % S=7.5; S_v=15; Br=0.6; Pe=2.5;
% % % % S=10; S_v=5; Br=0.9; Pe=5;

q=1.86;
s=1;
Dh=250*10^-6;
R=0:0.005:1;

Nc=[1/Pe^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];

Z1=6.5;
Nf1=Br*[(Z1^2).*exp(-2.*R.*Z1)+(Z1^2)*exp(-2*Z1)-2*Z1^2.*exp(-Z1-R.*Z1)];
Nr1=(R.^2*S.^2)/4 + (25.*R.^2*S.^2*(S_v))/(384*(1 + Z1^2/4 + Z1^4/64)^2)+
(R.^2.*R.*Z1^2*S.^2*(S_v))/(4*(1 + Z1^2/4 + Z1^4/64)^2) ...
(43.*R.^4*S.^2*Z1^2*(S_v))/(384*(1 + Z1^2/4 + Z1^4/64)^2) ...
+ (5.*R.^5.*R.*Z1*S.^2*Z1^3*(S_v))/(32*(1 + Z1^2/4 + Z1^4/64)^2)+
(407.*R.^6*S.^2*Z1^4*(S_v))/(4096*(1 + Z1^2/4 + Z1^4/64)^2) ...
(7.*R.^7.*R.*Z1^2*Z1^5*(S_v))/(768*(1 + Z1^2/4 + Z1^4/64)^2) ...
(539.*R.^8*S.^2*Z1^6*(S_v))/(4096*(1 + Z1^2/4 + Z1^4/64)^2) ...
(85225.*R.^10*S.^2*Z1^8*(S_v))/(1572864*(1 + Z1^2/4 + Z1^4/64)^2) ...
(6487.*R.^12*S.^2*Z1^10*(S_v))/(393216*(1 + Z1^2/4 + Z1^4/64)^2) ...
(17773.*R.^14*S.^2*Z1^12*(S_v))/(4194304*(1 + Z1^2/4 + Z1^4/64)^2) ...
(2011.*R.^16*S.^2*Z1^14*(S_v))/(2097152*(1 + Z1^2/4 + Z1^4/64)^2) ...
(206775.*R.^18*S.^2*Z1^16*(S_v))/(1073741824*(1 + Z1^2/4 + Z1^4/64)^2) ...
(108275.*R.^20*S.^2*Z1^18*(S_v))/(3221225472*(1 + Z1^2/4 + Z1^4/64)^2) ...
(512435.*R.^22*S.^2*Z1^20*(S_v))/(103079215104*(1 + Z1^2/4 + Z1^4/64)^2) ...
(21031.*R.^24*S.^2*Z1^22*(S_v))/(34359738368*(1 + Z1^2/4 + Z1^4/64)^2) ...
(272987.*R.^26*S.^2*Z1^24*(S_v))/(4398046511104*(1 + Z1^2/4 + Z1^4/64)^2) ...
(11305.*R.^28*S.^2*Z1^26*(S_v))/(2199023255552*(1 + Z1^2/4 + Z1^4/64)^2) ...
(24225.*R.^30*S.^2*Z1^28*(S_v))/(70368744177664*(1 + Z1^2/4 + Z1^4/64)^2) ...
(323.*R.^32*S.^2*Z1^30*(S_v))/(17592186044416*(1 + Z1^2/4 + Z1^4/64)^2) ...
(27455.*R.^34*S.^2*Z1^32*(S_v))/(36028797018963968*(1 + Z1^2/4 + Z1^4/64)^2) ...
(855.*R.^36*S.^2*Z1^34*(S_v))/(36028797018963968*(1 + Z1^2/4 + Z1^4/64)^2) ...
(1805.*R.^38*S.^2*Z1^36*(S_v))/(3458764513820540928*(1 + Z1^2/4 + Z1^4/64)^2) ...
(25.*R.^40*S.^2*Z1^38*(S_v))/(3458764513820540928*(1 + Z1^2/4 + Z1^4/64)^2) ...
(7.*R.^42*S.^2*Z1^40*(S_v))/(147573952589676412928*(1 + Z1^2/4 + Z1^4/64)^2) ...
(625.*R.^2*S.^2*(S_v)^2)/(147456*(1 + Z1^2/4 + Z1^4/64)^4) ...
(25.*R.^2.*R.*Z1^2*S.^2*(S_v)^2)/(768*(1 + Z1^2/4 + Z1^4/64)^4) ...
(R.^2.*R.*Z1^4*S.^2*(S_v)^2)/(16*(1 + Z1^2/4 + Z1^4/64)^4) ...
(1075.*R.^4*S.^2*Z1^2*(S_v)^2)/(73728*(1 + Z1^2/4 + Z1^4/64)^4) ...
(43.*R.^4.*R.*Z1^2*S.^2*Z1^2*(S_v)^2)/(768*(1 + Z1^2/4 + Z1^4/64)^4) ...

```

$$\begin{aligned}
& (125.*R.^5.*R.*Z1*S^2*Z1^3*(S_v)^2)/(6144*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (5.*R.^5.*R.*Z1^3*S^2*Z1^3*(S_v)^2)/(64*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (60109.*R.^6*S^2*Z1^4*(S_v)^2)/(2359296*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (407.*R.^6.*R.*Z1^2*S^2*Z1^4*(S_v)^2)/(8192*(1 + Z1^2/4 + Z1^4/64)^4) - \dots \\
& (4985.*R.^7.*R.*Z1*S^2*Z1^5*(S_v)^2)/(147456*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (7.*R.^7.*R.*Z1^3*S^2*Z1^5*(S_v)^2)/(1536*(1 + Z1^2/4 + Z1^4/64)^4) - \dots \\
& (671.*R.^8*S^2*Z1^6*(S_v)^2)/(131072*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (739.*R.^8.*R.*Z1^2*S^2*Z1^6*(S_v)^2)/(8192*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (17111.*R.^9.*R.*Z1*S^2*Z1^7*(S_v)^2)/(589824*(1 + Z1^2/4 + Z1^4/64)^4) - \\
& (3787661.*R.^10*S^2*Z1^8*(S_v)^2)/(301989888*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (31395.*R.^10.*R.*Z1^2*S^2*Z1^8*(S_v)^2)/(1048576*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (67529.*R.^11.*R.*Z1*S^2*Z1^9*(S_v)^2)/(1572864*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (1627151.*R.^12*S^2*Z1^10*(S_v)^2)/(100663296*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (19657.*R.^12.*R.*Z1^2*S^2*Z1^10*(S_v)^2)/(2359296*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (486493.*R.^13.*R.*Z1*S^2*Z1^11*(S_v)^2)/(25165824*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (241027273.*R.^14*S^2*Z1^12*(S_v)^2)/(9663676416*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (17773.*R.^14.*R.*Z1^2*S^2*Z1^12*(S_v)^2)/(8388608*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (3710335.*R.^15.*R.*Z1*S^2*Z1^13*(S_v)^2)/(603979776*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (53842355.*R.^16*S^2*Z1^14*(S_v)^2)/(3221225472*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (2011.*R.^16.*R.*Z1^2*S^2*Z1^14*(S_v)^2)/(4194304*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (981421.*R.^17.*R.*Z1*S^2*Z1^15*(S_v)^2)/(603979776*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (19618549477.*R.^18*S^2*Z1^16*(S_v)^2)/(2473901162496*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (206775.*R.^18.*R.*Z1^2*S^2*Z1^16*(S_v)^2)/(2147483648*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (607051.*R.^19.*R.*Z1*S^2*Z1^17*(S_v)^2)/(1610612736*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (944668661.*R.^20*S^2*Z1^18*(S_v)^2)/(309237645312*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (108275.*R.^20.*R.*Z1^2*S^2*Z1^18*(S_v)^2)/(6442450944*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (4002553.*R.^21.*R.*Z1*S^2*Z1^19*(S_v)^2)/(51539607552*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (3348433219.*R.^22*S^2*Z1^20*(S_v)^2)/(3298534883328*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (512435.*R.^22.*R.*Z1^2*S^2*Z1^20*(S_v)^2)/(206158430208*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (5778425.*R.^23.*R.*Z1*S^2*Z1^21*(S_v)^2)/(412316860416*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (1484626111.*R.^24*S^2*Z1^22*(S_v)^2)/(4947802324992*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (21031.*R.^24.*R.*Z1^2*S^2*Z1^22*(S_v)^2)/(68719476736*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (10718225.*R.^25.*R.*Z1*S^2*Z1^23*(S_v)^2)/(4947802324992*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (33848465467.*R.^26*S^2*Z1^24*(S_v)^2)/(422212465065984*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (272987.*R.^26.*R.*Z1^2*S^2*Z1^24*(S_v)^2)/(8796093022208*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (11158205.*R.^27.*R.*Z1*S^2*Z1^25*(S_v)^2)/(39582418599936*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (24750045961.*R.^28*S^2*Z1^26*(S_v)^2)/(1266637395197952*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (11305.*R.^28.*R.*Z1^2*S^2*Z1^26*(S_v)^2)/(4398046511104*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (6450277.*R.^29.*R.*Z1*S^2*Z1^27*(S_v)^2)/(211106232532992*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (59064594011.*R.^30*S^2*Z1^28*(S_v)^2)/(13510798882111488*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (24225.*R.^30.*R.*Z1^2*S^2*Z1^28*(S_v)^2)/(140737488355328*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (4624109.*R.^31.*R.*Z1*S^2*Z1^29*(S_v)^2)/(1688849860263936*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (36553306561.*R.^32*S^2*Z1^30*(S_v)^2)/(4053239646334464*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (323.*R.^32.*R.*Z1^2*S^2*Z1^30*(S_v)^2)/(35184372088832*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (679915.*R.^33.*R.*Z1*S^2*Z1^31*(S_v)^2)/(3377699720527872*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (1189947216611.*R.^34*S^2*Z1^32*(S_v)^2)/(6917529027641081856*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (27455.*R.^34.*R.*Z1^2*S^2*Z1^32*(S_v)^2)/(72057594037927936*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (108205.*R.^35.*R.*Z1*S^2*Z1^33*(S_v)^2)/(9007199254740992*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (105030792781.*R.^36*S^2*Z1^34*(S_v)^2)/(3458764513820540928*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (855.*R.^36.*R.*Z1^2*S^2*Z1^34*(S_v)^2)/(72057594037927936*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (990641.*R.^37.*R.*Z1*S^2*Z1^35*(S_v)^2)/(1729382256910270464*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (548568674633.*R.^38*S^2*Z1^36*(S_v)^2)/... \\
& (110680464442257309696*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (1805.*R.^38.*R.*Z1^2*S^2*Z1^36*(S_v)^2)/(6917529027641081856*(1 + Z1^2/4 + Z1^4/64)^4) + \dots \\
& (294785.*R.^39.*R.*Z1*S^2*Z1^37*(S_v)^2)/(13835058055282163712*(1 + Z1^2/4 + Z1^4/64)^4) + \\
& (10322387501.*R.^40*S^2*Z1^38*(S_v)^2)/...
\end{aligned}$$

$$\begin{aligned}
& (13835058055282163712*(1 + Z1^{2/4} + Z1^{4/64})^4) + \\
& (25.*R.^{40}.*R.*Z1^2*S^2*Z1^38*(S_v)^2)/(6917529027641081856*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.*Z1^*S^2*Z1^39*(S_v)^2)/(55340232221128654848*(1 + Z1^{2/4} + Z1^{4/64})^4) + \\
& (1462601471251.*R.^{42}S^2*Z1^40*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z1^{2/4} + Z1^{4/64})^4) + \\
& (7.*R.^{42}.*R.*Z1^2*S^2*Z1^40*(S_v)^2)/(295147905179352825856*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.*Z1^*S^2*Z1^41*(S_v)^2)/(1328165573307087716352*(1 + Z1^{2/4} + Z1^{4/64})^4) + \\
& (185335180013.*R.^{44}S^2*Z1^42*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z1^{2/4} + Z1^{4/64})^4) + \\
& (3115.*R.^{45}.*R.*Z1^*S^2*Z1^43*(S_v)^2)/(21250649172913403461632*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}S^2*Z1^44*(S_v)^2)/(1360041547066457821544448*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (49.*R.^{47}.*R.*Z1^*S^2*Z1^45*(S_v)^2)/(56668397794435742564352*(1 + Z1^{2/4} + Z1^{4/64})^4) + \\
& (24026340573.*R.^{48}S^2*Z1^46*(S_v)^2)/... \\
& (151115727451828646838272*(1 + Z1^{2/4} + Z1^{4/64})^4) + \\
& (5273670271697.*R.^{50}S^2*Z1^48*(S_v)^2)/(348170636049013202315378688*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (37823055319.*R.^{52}S^2*Z1^50*(S_v)^2)/(29014219670751100192948224*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (31266829573.*R.^{54}S^2*Z1^52*(S_v)^2)/(309485009821345068724781056*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (305764487.*R.^{56}S^2*Z1^54*(S_v)^2)/(43521329506126650289422336*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (155671821505.*R.^{58}S^2*Z1^56*(S_v)^2)/(356526731314189519170947776512*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (8605263625.*R.^{60}S^2*Z1^58*(S_v)^2)/(356526731314189519170947776512*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (4487015167.*R.^{62}S^2*Z1^60*(S_v)^2)/(3802951800684688204490109616128*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (64197131.*R.^{64}S^2*Z1^62*(S_v)^2)/(1267650600228229401496703205376*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (7366421503.*R.^{66}S^2*Z1^64*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (118374655.*R.^{68}S^2*Z1^66*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (103217975.*R.^{70}S^2*Z1^68*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (1169089.*R.^{72}S^2*Z1^70*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (16453715.*R.^{74}S^2*Z1^72*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (234365.*R.^{76}S^2*Z1^74*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (77905.*R.^{78}S^2*Z1^76*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (175.*R.^{80}S^2*Z1^78*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z1^{2/4} + Z1^{4/64})^4) + \dots \\
& (49.*R.^{82}S^2*Z1^80*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z1^{2/4} + Z1^{4/64})^4);
\end{aligned}$$

Ns1=Nf1+Nc+Nr1;  
 Phi1=Nf1./[Nc+Nr1];  
 Be1=1./[1+Phi1];  
 Gf1=Nf1./Ns1;  
 Gr1=[Nr1]./Ns1;  
 Nh1=Nc+Nr1;

Z2=7.5;

$$\begin{aligned}
Nf2 &= Br^*[(Z2^2).^*\exp(-2.^*R.^*Z2)+(Z2^2)^*\exp(-2.^*Z2)-2.^*Z2^2.^*\exp(-Z2-R.^*Z2)]; \\
Nr2 &= (R.^2.^*S^2)/4 + (25.^*R.^2.^*S^2.^*(S_v))/(384*(1 + Z2^2/4 + Z2^4/64)^2) + \\
&(R.^2.^*R.^*Z2^2.^*S^2.^*(S_v))/(4*(1 + Z2^2/4 + Z2^4/64)^2) - ... \\
&(43.^*R.^4.^*S^2.^*Z2^2.^*(S_v))/(384*(1 + Z2^2/4 + Z2^4/64)^2) - ... \\
&+ (5.^*R.^5.^*R.^*Z2^2.^*S^2.^*Z2^3.^*(S_v))/(32*(1 + Z2^2/4 + Z2^4/64)^2) + \\
&(407.^*R.^6.^*S^2.^*Z2^4.^*(S_v))/(4096*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(7.^*R.^7.^*R.^*Z2^2.^*S^2.^*Z2^5.^*(S_v))/(768*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(539.^*R.^8.^*S^2.^*Z2^6.^*(S_v))/(4096*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(85225.^*R.^10.^*S^2.^*Z2^8.^*(S_v))/(1572864*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(6487.^*R.^12.^*S^2.^*Z2^10.^*(S_v))/(393216*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(17773.^*R.^14.^*S^2.^*Z2^12.^*(S_v))/(4194304*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(2011.^*R.^16.^*S^2.^*Z2^14.^*(S_v))/(2097152*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(206775.^*R.^18.^*S^2.^*Z2^16.^*(S_v))/(1073741824*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(108275.^*R.^20.^*S^2.^*Z2^18.^*(S_v))/(3221225472*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(512435.^*R.^22.^*S^2.^*Z2^20.^*(S_v))/(103079215104*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(21031.^*R.^24.^*S^2.^*Z2^22.^*(S_v))/(34359738368*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(272987.^*R.^26.^*S^2.^*Z2^24.^*(S_v))/(4398046511104*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(11305.^*R.^28.^*S^2.^*Z2^26.^*(S_v))/(2199023255552*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(24225.^*R.^30.^*S^2.^*Z2^28.^*(S_v))/(70368744177664*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(323.^*R.^32.^*S^2.^*Z2^30.^*(S_v))/(17592186044416*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(27455.^*R.^34.^*S^2.^*Z2^32.^*(S_v))/(36028797018963968*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(855.^*R.^36.^*S^2.^*Z2^34.^*(S_v))/(36028797018963968*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(1805.^*R.^38.^*S^2.^*Z2^36.^*(S_v))/(3458764513820540928*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(25.^*R.^40.^*S^2.^*Z2^38.^*(S_v))/(3458764513820540928*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(7.^*R.^42.^*S^2.^*Z2^40.^*(S_v))/(147573952589676412928*(1 + Z2^2/4 + Z2^4/64)^2) + ... \\
&(625.^*R.^2.^*S^2.^*(S_v)^2)/(147456*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(25.^*R.^2.^*R.^*Z2^2.^*S^2.^*(S_v)^2)/(768*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(R.^2.^*R.^*Z2^4.^*S^2.^*(S_v)^2)/(16*(1 + Z2^2/4 + Z2^4/64)^4) - ... \\
&(1075.^*R.^4.^*S^2.^*Z2^2.^*(S_v)^2)/(73728*(1 + Z2^2/4 + Z2^4/64)^4) - ... \\
&(43.^*R.^4.^*R.^*Z2^2.^*S^2.^*Z2^2.^*(S_v)^2)/(768*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(125.^*R.^5.^*R.^*Z2^2.^*S^2.^*Z2^3.^*(S_v)^2)/(6144*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(5.^*R.^5.^*R.^*Z2^3.^*S^2.^*Z2^3.^*(S_v)^2)/(64*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(60109.^*R.^6.^*S^2.^*Z2^4.^*(S_v)^2)/(2359296*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(407.^*R.^6.^*R.^*Z2^2.^*S^2.^*Z2^4.^*(S_v)^2)/(8192*(1 + Z2^2/4 + Z2^4/64)^4) - ... \\
&(4985.^*R.^7.^*R.^*Z2^2.^*S^2.^*Z2^5.^*(S_v)^2)/(147456*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(7.^*R.^7.^*R.^*Z2^3.^*S^2.^*Z2^5.^*(S_v)^2)/(1536*(1 + Z2^2/4 + Z2^4/64)^4) - ... \\
&(671.^*R.^8.^*S^2.^*Z2^6.^*(S_v)^2)/(131072*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(739.^*R.^8.^*R.^*Z2^2.^*S^2.^*Z2^6.^*(S_v)^2)/(8192*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(17111.^*R.^9.^*R.^*Z2^2.^*S^2.^*Z2^7.^*(S_v)^2)/(589824*(1 + Z2^2/4 + Z2^4/64)^4) - ... \\
&(3787661.^*R.^10.^*S^2.^*Z2^8.^*(S_v)^2)/(301989888*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(31395.^*R.^10.^*R.^*Z2^2.^*S^2.^*Z2^8.^*(S_v)^2)/(1048576*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(67529.^*R.^11.^*R.^*Z2^2.^*S^2.^*Z2^9.^*(S_v)^2)/(1572864*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(1627151.^*R.^12.^*S^2.^*Z2^10.^*(S_v)^2)/(100663296*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(19657.^*R.^12.^*R.^*Z2^2.^*S^2.^*Z2^10.^*(S_v)^2)/(2359296*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(486493.^*R.^13.^*R.^*Z2^2.^*S^2.^*Z2^11.^*(S_v)^2)/(25165824*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(241027273.^*R.^14.^*S^2.^*Z2^12.^*(S_v)^2)/(9663676416*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(17773.^*R.^14.^*R.^*Z2^2.^*S^2.^*Z2^12.^*(S_v)^2)/(8388608*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(3710335.^*R.^15.^*R.^*Z2^2.^*S^2.^*Z2^13.^*(S_v)^2)/(603979776*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(53842355.^*R.^16.^*S^2.^*Z2^14.^*(S_v)^2)/(3221225472*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(2011.^*R.^16.^*R.^*Z2^2.^*S^2.^*Z2^14.^*(S_v)^2)/(4194304*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(981421.^*R.^17.^*R.^*Z2^2.^*S^2.^*Z2^15.^*(S_v)^2)/(603979776*(1 + Z2^2/4 + Z2^4/64)^4) + ... \\
&(19618549477.^*R.^18.^*S^2.^*Z2^16.^*(S_v)^2)/(2473901162496*(1 + Z2^2/4 + Z2^4/64)^4) + ...
\end{aligned}$$

$$\begin{aligned}
& (206775.*R.^{18}.*R.^{Z2^2*S^2*Z2^{16}}(S_v)^2)/(2147483648*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (607051.*R.^{19}.*R.^{Z2^2*S^2*Z2^{17}}(S_v)^2)/(1610612736*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (944668661.*R.^{20}.*R.^{Z2^2*S^2*Z2^{18}}(S_v)^2)/(309237645312*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (108275.*R.^{20}.*R.^{Z2^2*S^2*Z2^{18}}(S_v)^2)/(6442450944*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (4002553.*R.^{21}.*R.^{Z2^2*S^2*Z2^{19}}(S_v)^2)/(51539607552*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (3348433219.*R.^{22}.*R.^{Z2^2*S^2*Z2^{20}}(S_v)^2)/(3298534883328*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (512435.*R.^{22}.*R.^{Z2^2*S^2*Z2^{20}}(S_v)^2)/(206158430208*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (5778425.*R.^{23}.*R.^{Z2^2*S^2*Z2^{21}}(S_v)^2)/(412316860416*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (1484626111.*R.^{24}.*R.^{Z2^2*S^2*Z2^{22}}(S_v)^2)/(4947802324992*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (21031.*R.^{24}.*R.^{Z2^2*S^2*Z2^{22}}(S_v)^2)/(68719476736*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (10718225.*R.^{25}.*R.^{Z2^2*S^2*Z2^{23}}(S_v)^2)/(4947802324992*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (33848465467.*R.^{26}.*R.^{Z2^2*S^2*Z2^{24}}(S_v)^2)/(422212465065984*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (272987.*R.^{26}.*R.^{Z2^2*S^2*Z2^{24}}(S_v)^2)/(8796093022208*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (11158205.*R.^{27}.*R.^{Z2^2*S^2*Z2^{25}}(S_v)^2)/(39582418599936*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (24750045961.*R.^{28}.*R.^{Z2^2*S^2*Z2^{26}}(S_v)^2)/(1266637395197952*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (11305.*R.^{28}.*R.^{Z2^2*S^2*Z2^{26}}(S_v)^2)/(4398046511104*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (6450277.*R.^{29}.*R.^{Z2^2*S^2*Z2^{27}}(S_v)^2)/(211106232532992*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (59064594011.*R.^{30}.*R.^{Z2^2*S^2*Z2^{28}}(S_v)^2)/(1351079882111488*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (24225.*R.^{30}.*R.^{Z2^2*S^2*Z2^{28}}(S_v)^2)/(140737488355328*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (4624109.*R.^{31}.*R.^{Z2^2*S^2*Z2^{29}}(S_v)^2)/(1688849860263936*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (36553306561.*R.^{32}.*R.^{Z2^2*S^2*Z2^{30}}(S_v)^2)/(4053239646334464*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (323.*R.^{32}.*R.^{Z2^2*S^2*Z2^{30}}(S_v)^2)/(35184372088832*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (679915.*R.^{33}.*R.^{Z2^2*S^2*Z2^{31}}(S_v)^2)/(3377699720527872*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (1189947216611.*R.^{34}.*R.^{Z2^2*S^2*Z2^{32}}(S_v)^2)/(6917529027641081856*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (27455.*R.^{34}.*R.^{Z2^2*S^2*Z2^{32}}(S_v)^2)/(72057594037927936*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (108205.*R.^{35}.*R.^{Z2^2*S^2*Z2^{33}}(S_v)^2)/(9007199254740992*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (105030792781.*R.^{36}.*R.^{Z2^2*S^2*Z2^{34}}(S_v)^2)/(3458764513820540928*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (855.*R.^{36}.*R.^{Z2^2*S^2*Z2^{34}}(S_v)^2)/(72057594037927936*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.^{Z2^2*S^2*Z2^{35}}(S_v)^2)/(1729382256910270464*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (548568674633.*R.^{38}.*R.^{Z2^2*S^2*Z2^{36}}(S_v)^2)/... \\
& (110680464442257309696*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (1805.*R.^{38}.*R.^{Z2^2*S^2*Z2^{36}}(S_v)^2)/(6917529027641081856*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.^{Z2^2*S^2*Z2^{37}}(S_v)^2)/(13835058055282163712*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (10322387501.*R.^{40}.*R.^{Z2^2*S^2*Z2^{38}}(S_v)^2)/... \\
& (13835058055282163712*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (25.*R.^{40}.*R.^{Z2^2*S^2*Z2^{38}}(S_v)^2)/(6917529027641081856*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.^{Z2^2*S^2*Z2^{39}}(S_v)^2)/(55340232221128654848*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (1462601471251.*R.^{42}.*R.^{Z2^2*S^2*Z2^{40}}(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (7.*R.^{42}.*R.^{Z2^2*S^2*Z2^{40}}(S_v)^2)/(295147905179352825856*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.^{Z2^2*S^2*Z2^{41}}(S_v)^2)/(1328165573307087716352*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (185335180013.*R.^{44}.*R.^{Z2^2*S^2*Z2^{42}}(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (3115.*R.^{45}.*R.^{Z2^2*S^2*Z2^{43}}(S_v)^2)/(21250649172913403461632*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}.*R.^{Z2^2*S^2*Z2^{44}}(S_v)^2)/(1360041547066457821544448*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (49.*R.^{47}.*R.^{Z2^2*S^2*Z2^{45}}(S_v)^2)/(56668397794435742564352*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (24026340573.*R.^{48}.*R.^{Z2^2*S^2*Z2^{46}}(S_v)^2)/... \\
& (151115727451828646838272*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& (5273670271697.*R.^{50}.*R.^{Z2^2*S^2*Z2^{48}}(S_v)^2)/(348170636049013202315378688*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (37823055319.*R.^{52}.*R.^{Z2^2*S^2*Z2^{50}}(S_v)^2)/(29014219670751100192948224*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (31266829573.*R.^{54}.*R.^{Z2^2*S^2*Z2^{52}}(S_v)^2)/(309485009821345068724781056*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots
\end{aligned}$$

$$\begin{aligned}
& (305764487.*R.^{56}*S^2*Z2^{54}*(S_v)^2)/(43521329506126650289422336*(1 + Z2^{2/4} + Z2^{4/64})^4) + \\
& \dots \\
& (155671821505.*R.^{58}*S^2*Z2^{56}*(S_v)^2)/(356526731314189519170947776512*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (8605263625.*R.^{60}*S^2*Z2^{58}*(S_v)^2)/(356526731314189519170947776512*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (4487015167.*R.^{62}*S^2*Z2^{60}*(S_v)^2)/(3802951800684688204490109616128*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (64197131.*R.^{64}*S^2*Z2^{62}*(S_v)^2)/(1267650600228229401496703205376*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (7366421503.*R.^{66}*S^2*Z2^{64}*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (118374655.*R.^{68}*S^2*Z2^{66}*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (103217975.*R.^{70}*S^2*Z2^{68}*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (1169089.*R.^{72}*S^2*Z2^{70}*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (16453715.*R.^{74}*S^2*Z2^{72}*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (234365.*R.^{76}*S^2*Z2^{74}*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (77905.*R.^{78}*S^2*Z2^{76}*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (175.*R.^{80}*S^2*Z2^{78}*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z2^{2/4} + Z2^{4/64})^4) + \dots \\
& (49.*R.^{82}*S^2*Z2^{80}*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z2^{2/4} + Z2^{4/64})^4);
\end{aligned}$$

```

Ns2=Nf2+Nc+Nr2;
Phi2=Nf2./[Nc+Nr2];
Be2=1./[1+Phi2];
Gf2=Nf2./Ns2;
Gr2=[Nr2]./Ns2;
Nh2=Nc+Nr2;

```

$$\begin{aligned}
& Z3=10; \\
& Nf3=Br*[(Z3^2).*exp(-2.*R.*Z3)+(Z3^2)*exp(-2*Z3)-2*Z3^2.*exp(-Z3-R.*Z3)]; \\
& Nr3=(R.^2*S^2)/4 + (25.*R.^2*S^2*(S_v))/(384*(1 + Z3^{2/4} + Z3^{4/64})^2) + \\
& (R.^2.*R.*Z3^2*S^2*(S_v))/(4*(1 + Z3^{2/4} + Z3^{4/64})^2) - \dots \\
& (43.*R.^4*S^2*Z3^2*(S_v))/(384*(1 + Z3^{2/4} + Z3^{4/64})^2) - \dots \\
& + (5.*R.^5.*R.*Z3*S^2*Z3^3*(S_v))/(32*(1 + Z3^{2/4} + Z3^{4/64})^2) + \\
& (407.*R.^6*S^2*Z3^4*(S_v))/(4096*(1 + Z3^{2/4} + Z3^{4/64})^2) + \dots \\
& (7.*R.^7.*R.*Z3*S^2*Z3^5*(S_v))/(768*(1 + Z3^{2/4} + Z3^{4/64})^2) + \\
& (539.*R.^8*S^2*Z3^6*(S_v))/(4096*(1 + Z3^{2/4} + Z3^{4/64})^2) + \dots \\
& (85225.*R.^10*S^2*Z3^8*(S_v))/(1572864*(1 + Z3^{2/4} + Z3^{4/64})^2) + \\
& (6487.*R.^12*S^2*Z3^10*(S_v))/(393216*(1 + Z3^{2/4} + Z3^{4/64})^2) + \dots \\
& (17773.*R.^14*S^2*Z3^12*(S_v))/(4194304*(1 + Z3^{2/4} + Z3^{4/64})^2) + \\
& (2011.*R.^16*S^2*Z3^14*(S_v))/(2097152*(1 + Z3^{2/4} + Z3^{4/64})^2) + \dots \\
& (206775.*R.^18*S^2*Z3^16*(S_v))/(1073741824*(1 + Z3^{2/4} + Z3^{4/64})^2) + \\
& (108275.*R.^20*S^2*Z3^18*(S_v))/(3221225472*(1 + Z3^{2/4} + Z3^{4/64})^2) + \dots \\
& (512435.*R.^22*S^2*Z3^20*(S_v))/(103079215104*(1 + Z3^{2/4} + Z3^{4/64})^2) + \\
& (21031.*R.^24*S^2*Z3^22*(S_v))/(34359738368*(1 + Z3^{2/4} + Z3^{4/64})^2) + \dots \\
& (272987.*R.^26*S^2*Z3^24*(S_v))/(4398046511104*(1 + Z3^{2/4} + Z3^{4/64})^2) + \\
& (11305.*R.^28*S^2*Z3^26*(S_v))/(2199023255552*(1 + Z3^{2/4} + Z3^{4/64})^2) + \dots
\end{aligned}$$

$$\begin{aligned}
& (24225.*R.^{30}*S^{^2}*Z3^{^28}*(S_v))/(70368744177664*(1 + Z3^{^2/4} + Z3^{^4/64})^{^2}) + \\
& (323.*R.^{32}*S^{^2}*Z3^{^30}*(S_v))/(17592186044416*(1 + Z3^{^2/4} + Z3^{^4/64})^{^2}) + \dots \\
& (27455.*R.^{34}*S^{^2}*Z3^{^32}*(S_v))/(36028797018963968*(1 + Z3^{^2/4} + Z3^{^4/64})^{^2}) + \\
& (855.*R.^{36}*S^{^2}*Z3^{^34}*(S_v))/(36028797018963968*(1 + Z3^{^2/4} + Z3^{^4/64})^{^2}) + \dots \\
& (1805.*R.^{38}*S^{^2}*Z3^{^36}*(S_v))/(3458764513820540928*(1 + Z3^{^2/4} + Z3^{^4/64})^{^2}) + \\
& (25.*R.^{40}*S^{^2}*Z3^{^38}*(S_v))/(3458764513820540928*(1 + Z3^{^2/4} + Z3^{^4/64})^{^2}) + \dots \\
& (7.*R.^{42}*S^{^2}*Z3^{^40}*(S_v))/(147573952589676412928*(1 + Z3^{^2/4} + Z3^{^4/64})^{^2}) + \\
& (625.*R.^{42}*S^{^2}*(S_v)^{^2})/(147456*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (25.*R.^{42}.*R.^{42}*Z3^{^2}*S^{^2}*(S_v)^{^2})/(768*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (R.^{42}.*R.^{42}*Z3^{^4}*S^{^2}*(S_v)^{^2})/(16*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) - \dots \\
& (1075.*R.^{44}*S^{^2}*Z3^{^2}*(S_v)^{^2})/(73728*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) - \\
& (43.*R.^{44}.*R.^{44}*Z3^{^2}*S^{^2}*Z3^{^2}*(S_v)^{^2})/(768*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (125.*R.^{45}.*R.^{45}*Z3^{^3}*S^{^2}*Z3^{^3}*(S_v)^{^2})/(6144*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (5.*R.^{45}.*R.^{45}*Z3^{^3}*S^{^2}*Z3^{^3}*(S_v)^{^2})/(64*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (60109.*R.^{46}*S^{^2}*Z3^{^4}*(S_v)^{^2})/(2359296*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (407.*R.^{46}.*R.^{46}*Z3^{^2}*S^{^2}*Z3^{^4}*(S_v)^{^2})/(8192*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) - \dots \\
& (4985.*R.^{47}.*R.^{47}*Z3^{^3}*S^{^2}*Z3^{^5}*(S_v)^{^2})/(147456*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (7.*R.^{47}.*R.^{47}*Z3^{^3}*S^{^2}*Z3^{^5}*(S_v)^{^2})/(1536*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) - \dots \\
& (671.*R.^{48}*S^{^2}*Z3^{^6}*(S_v)^{^2})/(131072*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (739.*R.^{48}.*R.^{48}*Z3^{^2}*S^{^2}*Z3^{^6}*(S_v)^{^2})/(8192*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (17111.*R.^{49}.*R.^{49}*Z3^{^3}*S^{^2}*Z3^{^7}*(S_v)^{^2})/(589824*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) - \\
& (3787661.*R.^{49}.*R.^{49}*Z3^{^10}*S^{^2}*Z3^{^8}*(S_v)^{^2})/(301989888*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (31395.*R.^{49}.*R.^{49}*Z3^{^2}*S^{^2}*Z3^{^8}*(S_v)^{^2})/(1048576*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (67529.*R.^{49}.*R.^{49}*Z3^{^2}*S^{^2}*Z3^{^9}*(S_v)^{^2})/(1572864*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (1627151.*R.^{49}.*R.^{49}*Z3^{^2}*S^{^2}*Z3^{^10}*(S_v)^{^2})/(100663296*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (19657.*R.^{49}.*R.^{49}*Z3^{^2}*S^{^2}*Z3^{^10}*(S_v)^{^2})/(2359296*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (486493.*R.^{13}.*R.^{13}*Z3^{^3}*S^{^2}*Z3^{^11}*(S_v)^{^2})/(25165824*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (241027273.*R.^{14}*S^{^2}*Z3^{^12}*(S_v)^{^2})/(9663676416*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (17773.*R.^{14}.*R.^{14}*Z3^{^2}*S^{^2}*Z3^{^12}*(S_v)^{^2})/(8388608*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (3710335.*R.^{14}.*R.^{14}*Z3^{^2}*S^{^2}*Z3^{^13}*(S_v)^{^2})/(603979776*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (53842355.*R.^{14}.*R.^{14}*Z3^{^2}*S^{^2}*Z3^{^14}*(S_v)^{^2})/(3221225472*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (2011.*R.^{16}.*R.^{16}*Z3^{^2}*S^{^2}*Z3^{^14}*(S_v)^{^2})/(4194304*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (981421.*R.^{17}.*R.^{17}*Z3^{^2}*S^{^2}*Z3^{^15}*(S_v)^{^2})/(603979776*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (19618549477.*R.^{18}*S^{^2}*Z3^{^16}*(S_v)^{^2})/(2473901162496*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (206775.*R.^{18}.*R.^{18}*Z3^{^2}*S^{^2}*Z3^{^16}*(S_v)^{^2})/(2147483648*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (607051.*R.^{19}.*R.^{19}*Z3^{^2}*S^{^2}*Z3^{^17}*(S_v)^{^2})/(1610612736*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (944668661.*R.^{19}.*R.^{19}*Z3^{^2}*S^{^2}*Z3^{^18}*(S_v)^{^2})/(309237645312*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (108275.*R.^{20}.*R.^{20}*Z3^{^2}*S^{^2}*Z3^{^18}*(S_v)^{^2})/(6442450944*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (4002553.*R.^{21}.*R.^{21}*Z3^{^2}*S^{^2}*Z3^{^19}*(S_v)^{^2})/(51539607552*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (3348433219.*R.^{22}*S^{^2}*Z3^{^20}*(S_v)^{^2})/(3298534883328*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (512435.*R.^{22}.*R.^{22}*Z3^{^2}*S^{^2}*Z3^{^20}*(S_v)^{^2})/(206158430208*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (5778425.*R.^{23}.*R.^{23}*Z3^{^2}*S^{^2}*Z3^{^21}*(S_v)^{^2})/(412316860416*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (1484626111.*R.^{24}*S^{^2}*Z3^{^22}*(S_v)^{^2})/(4947802324992*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (21031.*R.^{24}.*R.^{24}*Z3^{^2}*S^{^2}*Z3^{^22}*(S_v)^{^2})/(68719476736*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (10718225.*R.^{25}.*R.^{25}*Z3^{^2}*S^{^2}*Z3^{^23}*(S_v)^{^2})/(4947802324992*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (33848465467.*R.^{26}*S^{^2}*Z3^{^24}*(S_v)^{^2})/(422212465065984*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (272987.*R.^{26}.*R.^{26}*Z3^{^2}*S^{^2}*Z3^{^24}*(S_v)^{^2})/(8796093022208*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (11158205.*R.^{27}.*R.^{27}*Z3^{^2}*S^{^2}*Z3^{^25}*(S_v)^{^2})/(39582418599936*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (24750045961.*R.^{28}*S^{^2}*Z3^{^26}*(S_v)^{^2})/(1266637395197952*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (11305.*R.^{28}.*R.^{28}*Z3^{^2}*S^{^2}*Z3^{^26}*(S_v)^{^2})/(4398046511104*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (6450277.*R.^{29}.*R.^{29}*Z3^{^2}*S^{^2}*Z3^{^27}*(S_v)^{^2})/(211106232532992*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (59064594011.*R.^{29}.*R.^{29}*Z3^{^2}*S^{^2}*Z3^{^28}*(S_v)^{^2})/(1351079882111488*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (24225.*R.^{30}.*R.^{30}*Z3^{^2}*S^{^2}*Z3^{^28}*(S_v)^{^2})/(140737488355328*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (4624109.*R.^{31}.*R.^{31}*Z3^{^2}*S^{^2}*Z3^{^29}*(S_v)^{^2})/(1688849860263936*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots \\
& (36553306561.*R.^{32}.*R.^{32}*Z3^{^2}*S^{^2}*Z3^{^30}*(S_v)^{^2})/(405323964646334464*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \\
& (323.*R.^{32}.*R.^{32}*Z3^{^2}*S^{^2}*Z3^{^30}*(S_v)^{^2})/(35184372088832*(1 + Z3^{^2/4} + Z3^{^4/64})^{^4}) + \dots
\end{aligned}$$

$$\begin{aligned}
& (679915.*R.^{33}.*R.^{32}*Z3^{31}*(S_v)^2)/(3377699720527872*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (1189947216611.*R.^{34}*S^{2*Z3^{32}}*(S_v)^2)/(6917529027641081856*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (27455.*R.^{34}.*R.^{32}*Z3^{32}*(S_v)^2)/(72057594037927936*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (108205.*R.^{35}.*R.^{32}*Z3^{33}*(S_v)^2)/(9007199254740992*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (105030792781.*R.^{36}*S^{2*Z3^{34}}*(S_v)^2)/(3458764513820540928*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (855.*R.^{36}.*R.^{32}*Z3^{34}*(S_v)^2)/(72057594037927936*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.^{32}*Z3^{35}*(S_v)^2)/(1729382256910270464*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (548568674633.*R.^{38}*S^{2*Z3^{36}}*(S_v)^2)/... \\
& (110680464442257309696*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (1805.*R.^{38}.*R.^{32}*Z3^{36}*(S_v)^2)/(6917529027641081856*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.^{32}*Z3^{37}*(S_v)^2)/(13835058055282163712*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (10322387501.*R.^{40}*S^{2*Z3^{38}}*(S_v)^2)/... \\
& (13835058055282163712*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (25.*R.^{40}.*R.^{32}*Z3^{38}*(S_v)^2)/(6917529027641081856*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.^{32}*Z3^{39}*(S_v)^2)/(55340232221128654848*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (1462601471251.*R.^{42}*S^{2*Z3^{40}}*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (7.*R.^{42}.*R.^{32}*Z3^{40}*(S_v)^2)/(295147905179352825856*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.^{32}*Z3^{41}*(S_v)^2)/(1328165573307087716352*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (185335180013.*R.^{44}*S^{2*Z3^{42}}*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (3115.*R.^{45}.*R.^{32}*Z3^{43}*(S_v)^2)/(21250649172913403461632*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}*S^{2*Z3^{44}}*(S_v)^2)/(1360041547066457821544448*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (49.*R.^{47}.*R.^{32}*Z3^{45}*(S_v)^2)/(56668397794435742564352*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (24026340573.*R.^{48}*S^{2*Z3^{46}}*(S_v)^2)/... \\
& (151115727451828646838272*(1 + Z3^{2/4} + Z3^{4/64})^4) + \\
& (5273670271697.*R.^{50}*S^{2*Z3^{48}}*(S_v)^2)/(348170636049013202315378688*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (37823055319.*R.^{52}*S^{2*Z3^{50}}*(S_v)^2)/(29014219670751100192948224*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (31266829573.*R.^{54}*S^{2*Z3^{52}}*(S_v)^2)/(309485009821345068724781056*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (305764487.*R.^{56}*S^{2*Z3^{54}}*(S_v)^2)/(43521329506126650289422336*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (155671821505.*R.^{58}*S^{2*Z3^{56}}*(S_v)^2)/(356526731314189519170947776512*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (8605263625.*R.^{60}*S^{2*Z3^{58}}*(S_v)^2)/(356526731314189519170947776512*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (4487015167.*R.^{62}*S^{2*Z3^{60}}*(S_v)^2)/(3802951800684688204490109616128*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (64197131.*R.^{64}*S^{2*Z3^{62}}*(S_v)^2)/(1267650600228229401496703205376*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (7366421503.*R.^{66}*S^{2*Z3^{64}}*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (118374655.*R.^{68}*S^{2*Z3^{66}}*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (103217975.*R.^{70}*S^{2*Z3^{68}}*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (1169089.*R.^{72}*S^{2*Z3^{70}}*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (16453715.*R.^{74}*S^{2*Z3^{72}}*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (234365.*R.^{76}*S^{2*Z3^{74}}*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots
\end{aligned}$$

$$\begin{aligned}
& (77905.*R.^78*S^2*Z3^76*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (175.*R.^80*S^2*Z3^78*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z3^{2/4} + Z3^{4/64})^4) + \dots \\
& (49.*R.^82*S^2*Z3^80*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z3^{2/4} + Z3^{4/64})^4);
\end{aligned}$$

```

Ns3=Nf3+Nc+Nr3;
Phi3=Nf3./[Nc+Nr3];
Be3=1./[1+Phi3];
Gf3=Nf3./Ns3;
Gr3=[Nr3]./Ns3;
Nh3=Nc+Nr3;

```

$$\begin{aligned}
Z4 &= 12.5; \\
Nf4 &= Br^*[(Z4^2).*exp(-2.*R.*Z4)+(Z4^2)*exp(-2*Z4)-2*Z4^2.*exp(-Z4-R.*Z4)]; \\
Nr4 &= (R.^2*S^2)/4 + (25.*R.^2*S^2*(S_v))/(384*(1 + Z4^{2/4} + Z4^{4/64})^2) + \\
& (R.^2.*R.*Z4^2*S^2*(S_v))/(4*(1 + Z4^{2/4} + Z4^{4/64})^2) - \dots \\
& (43.*R.^4*S^2*Z4^2*(S_v))/(384*(1 + Z4^{2/4} + Z4^{4/64})^2) - \dots \\
& + (5.*R.^5.*R.*Z4*S^2*Z4^3*(S_v))/(32*(1 + Z4^{2/4} + Z4^{4/64})^2) + \\
(407.*R.^6*S^2*Z4^4*(S_v)) &/(4096*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (7.*R.^7.*R.*Z4*S^2*Z4^5*(S_v))/(768*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (539.*R.^8*S^2*Z4^6*(S_v))/(4096*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (85225.*R.^10*S^2*Z4^8*(S_v))/(1572864*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (6487.*R.^12*S^2*Z4^10*(S_v))/(393216*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (17773.*R.^14*S^2*Z4^12*(S_v))/(4194304*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (2011.*R.^16*S^2*Z4^14*(S_v))/(2097152*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (206775.*R.^18*S^2*Z4^16*(S_v))/(1073741824*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (108275.*R.^20*S^2*Z4^18*(S_v))/(3221225472*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (512435.*R.^22*S^2*Z4^20*(S_v))/(103079215104*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (21031.*R.^24*S^2*Z4^22*(S_v))/(34359738368*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (272987.*R.^26*S^2*Z4^24*(S_v))/(4398046511104*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (11305.*R.^28*S^2*Z4^26*(S_v))/(2199023255552*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (24225.*R.^30*S^2*Z4^28*(S_v))/(70368744177664*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (323.*R.^32*S^2*Z4^30*(S_v))/(17592186044416*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (27455.*R.^34*S^2*Z4^32*(S_v))/(36028797018963968*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (855.*R.^36*S^2*Z4^34*(S_v))/(36028797018963968*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (1805.*R.^38*S^2*Z4^36*(S_v))/(3458764513820540928*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (25.*R.^40*S^2*Z4^38*(S_v))/(3458764513820540928*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (7.*R.^42*S^2*Z4^40*(S_v))/(147573952589676412928*(1 + Z4^{2/4} + Z4^{4/64})^2) + \dots \\
& (625.*R.^42*S^2*(S_v)^2)/(147456*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (25.*R.^2.*R.*Z4^2*S^2*(S_v)^2)/(768*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
(R.^2.*R.*Z4^4*S^2*(S_v)^2) &/(16*(1 + Z4^{2/4} + Z4^{4/64})^4) - \dots \\
& (1075.*R.^4*S^2*Z4^2*(S_v)^2)/(73728*(1 + Z4^{2/4} + Z4^{4/64})^4) - \dots \\
& (43.*R.^4.*R.*Z4^2*S^2*Z4^2*(S_v)^2)/(768*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (125.*R.^5.*R.*Z4^3*S^2*Z4^3*(S_v)^2)/(6144*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (5.*R.^5.*R.*Z4^3*S^2*Z4^3*(S_v)^2)/(64*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (60109.*R.^6*S^2*Z4^4*(S_v)^2)/(2359296*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (407.*R.^6.*R.*Z4^2*S^2*Z4^4*(S_v)^2)/(8192*(1 + Z4^{2/4} + Z4^{4/64})^4) - \dots \\
& (4985.*R.^7.*R.*Z4*S^2*Z4^5*(S_v)^2)/(147456*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (7.*R.^7.*R.*Z4^3*S^2*Z4^5*(S_v)^2)/(1536*(1 + Z4^{2/4} + Z4^{4/64})^4) - \dots \\
& (671.*R.^8*S^2*Z4^6*(S_v)^2)/(131072*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (739.*R.^8.*R.*Z4^2*S^2*Z4^6*(S_v)^2)/(8192*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (17111.*R.^9.*R.*Z4*S^2*Z4^7*(S_v)^2)/(589824*(1 + Z4^{2/4} + Z4^{4/64})^4) - \dots \\
& (3787661.*R.^10*S^2*Z4^8*(S_v)^2)/(301989888*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots
\end{aligned}$$

$$\begin{aligned}
& (31395.*R.^{10}.*R.^{Z4^2*S^2*Z4^8*(S_v)^2})/(1048576*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (67529.*R.^{11}.*R.^{Z4^2*S^2*Z4^9*(S_v)^2})/(1572864*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (1627151.*R.^{12}.*R.^{Z4^2*S^2*Z4^{10}*(S_v)^2})/(100663296*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (19657.*R.^{12}.*R.^{Z4^2*S^2*Z4^{10}*(S_v)^2})/(2359296*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (486493.*R.^{13}.*R.^{Z4^2*S^2*Z4^{11}*(S_v)^2})/(25165824*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (241027273.*R.^{14}.*R.^{Z4^2*S^2*Z4^{12}*(S_v)^2})/(9663676416*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (17773.*R.^{14}.*R.^{Z4^2*S^2*Z4^{12}*(S_v)^2})/(8388608*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (3710335.*R.^{15}.*R.^{Z4^2*S^2*Z4^{13}*(S_v)^2})/(603979776*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (53842355.*R.^{16}.*R.^{Z4^2*S^2*Z4^{14}*(S_v)^2})/(3221225472*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (2011.*R.^{16}.*R.^{Z4^2*S^2*Z4^{14}*(S_v)^2})/(4194304*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (981421.*R.^{17}.*R.^{Z4^2*S^2*Z4^{15}*(S_v)^2})/(603979776*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (19618549477.*R.^{18}.*R.^{Z4^2*S^2*Z4^{16}*(S_v)^2})/(2473901162496*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (206775.*R.^{18}.*R.^{Z4^2*S^2*Z4^{16}*(S_v)^2})/(2147483648*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (607051.*R.^{19}.*R.^{Z4^2*S^2*Z4^{17}*(S_v)^2})/(1610612736*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (944668661.*R.^{20}.*R.^{Z4^2*S^2*Z4^{18}*(S_v)^2})/(309237645312*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (108275.*R.^{20}.*R.^{Z4^2*S^2*Z4^{18}*(S_v)^2})/(6442450944*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (4002553.*R.^{21}.*R.^{Z4^2*S^2*Z4^{19}*(S_v)^2})/(51539607552*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (3348433219.*R.^{22}.*R.^{Z4^2*S^2*Z4^{20}*(S_v)^2})/(3298534883328*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (512435.*R.^{22}.*R.^{Z4^2*S^2*Z4^{20}*(S_v)^2})/(206158430208*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (5778425.*R.^{23}.*R.^{Z4^2*S^2*Z4^{21}*(S_v)^2})/(412316860416*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (1484626111.*R.^{24}.*R.^{Z4^2*S^2*Z4^{22}*(S_v)^2})/(4947802324992*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (21031.*R.^{24}.*R.^{Z4^2*S^2*Z4^{22}*(S_v)^2})/(68719476736*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (10718225.*R.^{25}.*R.^{Z4^2*S^2*Z4^{23}*(S_v)^2})/(4947802324992*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (33848465467.*R.^{26}.*R.^{Z4^2*S^2*Z4^{24}*(S_v)^2})/(422212465065984*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (272987.*R.^{26}.*R.^{Z4^2*S^2*Z4^{24}*(S_v)^2})/(8796093022208*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (11158205.*R.^{27}.*R.^{Z4^2*S^2*Z4^{25}*(S_v)^2})/(39582418599936*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (24750045961.*R.^{28}.*R.^{Z4^2*S^2*Z4^{26}*(S_v)^2})/(1266637395197952*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (11305.*R.^{28}.*R.^{Z4^2*S^2*Z4^{26}*(S_v)^2})/(4398046511104*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (6450277.*R.^{29}.*R.^{Z4^2*S^2*Z4^{27}*(S_v)^2})/(211106232532992*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (59064594011.*R.^{30}.*R.^{Z4^2*S^2*Z4^{28}*(S_v)^2})/(13510798882111488*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (24225.*R.^{30}.*R.^{Z4^2*S^2*Z4^{28}*(S_v)^2})/(140737488355328*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (4624109.*R.^{31}.*R.^{Z4^2*S^2*Z4^{29}*(S_v)^2})/(1688849860263936*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (36553306561.*R.^{32}.*R.^{Z4^2*S^2*Z4^{30}*(S_v)^2})/(40532396464334464*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (323.*R.^{32}.*R.^{Z4^2*S^2*Z4^{30}*(S_v)^2})/(35184372088832*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (679915.*R.^{33}.*R.^{Z4^2*S^2*Z4^{31}*(S_v)^2})/(3377699720527872*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (1189947216611.*R.^{34}.*R.^{Z4^2*S^2*Z4^{32}*(S_v)^2})/(6917529027641081856*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (27455.*R.^{34}.*R.^{Z4^2*S^2*Z4^{32}*(S_v)^2})/(72057594037927936*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (108205.*R.^{35}.*R.^{Z4^2*S^2*Z4^{33}*(S_v)^2})/(9007199254740992*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (105030792781.*R.^{36}.*R.^{Z4^2*S^2*Z4^{34}*(S_v)^2})/(3458764513820540928*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (855.*R.^{36}.*R.^{Z4^2*S^2*Z4^{34}*(S_v)^2})/(72057594037927936*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.^{Z4^2*S^2*Z4^{35}*(S_v)^2})/(1729382256910270464*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (548568674633.*R.^{38}.*R.^{Z4^2*S^2*Z4^{36}*(S_v)^2})/... \\
& (110680464442257309696*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (1805.*R.^{38}.*R.^{Z4^2*S^2*Z4^{36}*(S_v)^2})/(6917529027641081856*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.^{Z4^2*S^2*Z4^{37}*(S_v)^2})/(13835058055282163712*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (10322387501.*R.^{40}.*R.^{Z4^2*S^2*Z4^{38}*(S_v)^2})/... \\
& (13835058055282163712*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (25.*R.^{40}.*R.^{Z4^2*S^2*Z4^{38}*(S_v)^2})/(6917529027641081856*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.^{Z4^2*S^2*Z4^{39}*(S_v)^2})/(5534023221128654848*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (1462601471251.*R.^{42}.*R.^{Z4^2*S^2*Z4^{40}*(S_v)^2})/... \\
& (14167099448608935641088*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (7.*R.^{42}.*R.^{Z4^2*S^2*Z4^{40}*(S_v)^2})/(295147905179352825856*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.^{Z4^2*S^2*Z4^{41}*(S_v)^2})/(1328165573307087716352*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (185335180013.*R.^{44}.*R.^{Z4^2*S^2*Z4^{42}*(S_v)^2})/... \\
& (14167099448608935641088*(1 + Z4^{2/4} + Z4^{4/64})^4) + \\
& (3115.*R.^{45}.*R.^{Z4^2*S^2*Z4^{43}*(S_v)^2})/(21250649172913403461632*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots
\end{aligned}$$

$$\begin{aligned}
& (2057042720599.*R.^46*S^2*Z4^44*(S_v)^2)/(1360041547066457821544448*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (49.*R.^47.*R.^Z4^2*Z4^45*(S_v)^2)/(56668397794435742564352*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (24026340573.*R.^48*S^2*Z4^46*(S_v)^2)/... \\
& (151115727451828646838272*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (5273670271697.*R.^50*S^2*Z4^48*(S_v)^2)/(348170636049013202315378688*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (37823055319.*R.^52*S^2*Z4^50*(S_v)^2)/(29014219670751100192948224*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (31266829573.*R.^54*S^2*Z4^52*(S_v)^2)/(309485009821345068724781056*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (305764487.*R.^56*S^2*Z4^54*(S_v)^2)/(43521329506126650289422336*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (155671821505.*R.^58*S^2*Z4^56*(S_v)^2)/(356526731314189519170947776512*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (8605263625.*R.^60*S^2*Z4^58*(S_v)^2)/(356526731314189519170947776512*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (4487015167.*R.^62*S^2*Z4^60*(S_v)^2)/(3802951800684688204490109616128*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (64197131.*R.^64*S^2*Z4^62*(S_v)^2)/(1267650600228229401496703205376*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (7366421503.*R.^66*S^2*Z4^64*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (118374655.*R.^68*S^2*Z4^66*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (103217975.*R.^70*S^2*Z4^68*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (1169089.*R.^72*S^2*Z4^70*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (16453715.*R.^74*S^2*Z4^72*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (234365.*R.^76*S^2*Z4^74*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (77905.*R.^78*S^2*Z4^76*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (175.*R.^80*S^2*Z4^78*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z4^{2/4} + Z4^{4/64})^4) + \dots \\
& (49.*R.^82*S^2*Z4^80*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z4^{2/4} + Z4^{4/64})^4);
\end{aligned}$$

Ns4=Nf4+Nc+Nr4;  
 Phi4=Nf4./[Nc+Nr4];  
 Be4=1./[1+Phi4];  
 Gf4=Nf4./Ns4;  
 Gr4=[Nr4]./Ns4;  
 Nh4=Nc+Nr4;

Z5=15;  
 Nf5=Br\*[(Z5^2).\*exp(-2.\*R.\*Z5)+(Z5^2)\*exp(-2\*Z5)-2\*Z5^2.\*exp(-Z5-R.\*Z5)];  
 Nr5=(R.^2\*S^2)/4 + (25.\*R.^2\*S^2\*(S\_v))/(384\*(1 + Z5^{2/4} + Z5^{4/64})^2) + (R.^2.\*R.\*Z5^2\*S^2\*(S\_v))/(4\*(1 + Z5^{2/4} + Z5^{4/64})^2) - ...  
 (43.\*R.^4\*S^2\*Z5^2\*(S\_v))/(384\*(1 + Z5^{2/4} + Z5^{4/64})^2)...  
 + (5.\*R.^5.\*R.\*Z5\*S^2\*Z5^3\*(S\_v))/(32\*(1 + Z5^{2/4} + Z5^{4/64})^2) + (407.\*R.^6\*S^2\*Z5^4\*(S\_v))/(4096\*(1 + Z5^{2/4} + Z5^{4/64})^2) + ...

$$\begin{aligned}
& (7.*R.^7.*R.*Z5*S^2*Z5^5*(S_v))/(768*(1 + Z5^{2/4} + Z5^{4/64})^2) + \\
& (539.*R.^8*S^2*Z5^6*(S_v))/(4096*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (85225.*R.^10*S^2*Z5^8*(S_v))/(1572864*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (6487.*R.^12*S^2*Z5^10*(S_v))/(393216*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (17773.*R.^14*S^2*Z5^12*(S_v))/(4194304*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (2011.*R.^16*S^2*Z5^14*(S_v))/(2097152*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (206775.*R.^18*S^2*Z5^16*(S_v))/(1073741824*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (108275.*R.^20*S^2*Z5^18*(S_v))/(3221225472*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (512435.*R.^22*S^2*Z5^20*(S_v))/(103079215104*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (21031.*R.^24*S^2*Z5^22*(S_v))/(34359738368*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (272987.*R.^26*S^2*Z5^24*(S_v))/(4398046511104*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (11305.*R.^28*S^2*Z5^26*(S_v))/(2199023255552*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (24225.*R.^30*S^2*Z5^28*(S_v))/(70368744177664*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (323.*R.^32*S^2*Z5^30*(S_v))/(17592186044416*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (27455.*R.^34*S^2*Z5^32*(S_v))/(36028797018963968*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (855.*R.^36*S^2*Z5^34*(S_v))/(36028797018963968*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (1805.*R.^38*S^2*Z5^36*(S_v))/(3458764513820540928*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (25.*R.^40*S^2*Z5^38*(S_v))/(3458764513820540928*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (7.*R.^42*S^2*Z5^40*(S_v))/(147573952589676412928*(1 + Z5^{2/4} + Z5^{4/64})^2) + \dots \\
& (625.*R.^42*S^2*(S_v)^2)/(147456*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (25.*R.^2.*R.*Z5^2*S^2*(S_v)^2)/(768*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (R.^2.*R.*Z5^4*S^2*(S_v)^2)/(16*(1 + Z5^{2/4} + Z5^{4/64})^4) - \dots \\
& (1075.*R.^4*S^2*Z5^2*(S_v)^2)/(73728*(1 + Z5^{2/4} + Z5^{4/64})^4) - \dots \\
& (43.*R.^4.*R.*Z5^2*S^2*Z5^2*(S_v)^2)/(768*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (125.*R.^5.*R.*Z5^2*S^2*Z5^3*(S_v)^2)/(6144*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (5.*R.^5.*R.*Z5^3*S^2*Z5^3*(S_v)^2)/(64*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (60109.*R.^6*S^2*Z5^4*(S_v)^2)/(2359296*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (407.*R.^6.*R.*Z5^2*S^2*Z5^4*(S_v)^2)/(8192*(1 + Z5^{2/4} + Z5^{4/64})^4) - \dots \\
& (4985.*R.^7.*R.*Z5^2*S^2*Z5^5*(S_v)^2)/(147456*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (7.*R.^7.*R.*Z5^3*S^2*Z5^5*(S_v)^2)/(1536*(1 + Z5^{2/4} + Z5^{4/64})^4) - \dots \\
& (671.*R.^8*S^2*Z5^6*(S_v)^2)/(131072*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (739.*R.^8.*R.*Z5^2*S^2*Z5^6*(S_v)^2)/(8192*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (17111.*R.^9.*R.*Z5^2*S^2*Z5^7*(S_v)^2)/(589824*(1 + Z5^{2/4} + Z5^{4/64})^4) - \dots \\
& (3787661.*R.^10*S^2*Z5^8*(S_v)^2)/(301989888*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (31395.*R.^10.*R.*Z5^2*S^2*Z5^8*(S_v)^2)/(1048576*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (67529.*R.^11.*R.*Z5^2*S^2*Z5^9*(S_v)^2)/(1572864*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (1627151.*R.^12*S^2*Z5^10*(S_v)^2)/(100663296*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (19657.*R.^12.*R.*Z5^2*S^2*Z5^10*(S_v)^2)/(2359296*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (486493.*R.^13.*R.*Z5^2*S^2*Z5^11*(S_v)^2)/(25165824*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (241027273.*R.^14*S^2*Z5^12*(S_v)^2)/(9663676416*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (17773.*R.^14.*R.*Z5^2*S^2*Z5^12*(S_v)^2)/(8388608*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (3710335.*R.^15.*R.*Z5^2*S^2*Z5^13*(S_v)^2)/(603979776*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (53842355.*R.^16*S^2*Z5^14*(S_v)^2)/(3221225472*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (2011.*R.^16.*R.*Z5^2*S^2*Z5^14*(S_v)^2)/(4194304*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (981421.*R.^17.*R.*Z5^2*S^2*Z5^15*(S_v)^2)/(603979776*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (19618549477.*R.^18*S^2*Z5^16*(S_v)^2)/(2473901162496*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (206775.*R.^18.*R.*Z5^2*S^2*Z5^16*(S_v)^2)/(2147483648*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (607051.*R.^19.*R.*Z5^2*S^2*Z5^17*(S_v)^2)/(1610612736*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (944668661.*R.^20*S^2*Z5^18*(S_v)^2)/(309237645312*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (108275.*R.^20.*R.*Z5^2*S^2*Z5^18*(S_v)^2)/(6442450944*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (4002553.*R.^21.*R.*Z5^2*S^2*Z5^19*(S_v)^2)/(51539607552*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (3348433219.*R.^22*S^2*Z5^20*(S_v)^2)/(3298534883328*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (512435.*R.^22.*R.*Z5^2*S^2*Z5^20*(S_v)^2)/(206158430208*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (5778425.*R.^23.*R.*Z5^2*S^2*Z5^21*(S_v)^2)/(412316860416*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (1484626111.*R.^24*S^2*Z5^22*(S_v)^2)/(4947802324992*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (21031.*R.^24.*R.*Z5^2*S^2*Z5^22*(S_v)^2)/(68719476736*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots
\end{aligned}$$

$$\begin{aligned}
& (10718225.*R.^{25}.*R.*Z5*S^2*Z5^{23}*(S_v)^2)/(4947802324992*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (33848465467.*R.^{26}*S^2*Z5^{24}*(S_v)^2)/(422212465065984*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (272987.*R.^{26}.*R.*Z5^2*S^2*Z5^{24}*(S_v)^2)/(8796093022208*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (11158205.*R.^{27}.*R.*Z5*S^2*Z5^{25}*(S_v)^2)/(39582418599936*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (24750045961.*R.^{28}*S^2*Z5^{26}*(S_v)^2)/(1266637395197952*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (11305.*R.^{28}.*R.*Z5^2*S^2*Z5^{26}*(S_v)^2)/(4398046511104*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (6450277.*R.^{29}.*R.*Z5*S^2*Z5^{27}*(S_v)^2)/(211106232532992*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (59064594011.*R.^{30}*S^2*Z5^{28}*(S_v)^2)/(13510798882111488*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (24225.*R.^{30}.*R.*Z5^2*S^2*Z5^{28}*(S_v)^2)/(140737488355328*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (4624109.*R.^{31}.*R.*Z5*S^2*Z5^{29}*(S_v)^2)/(1688849860263936*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (36553306561.*R.^{32}*S^2*Z5^{30}*(S_v)^2)/(40532396464334464*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (323.*R.^{32}.*R.*Z5^2*S^2*Z5^{30}*(S_v)^2)/(35184372088832*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (679915.*R.^{33}.*R.*Z5*S^2*Z5^{31}*(S_v)^2)/(3377699720527872*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (1189947216611.*R.^{34}*S^2*Z5^{32}*(S_v)^2)/(6917529027641081856*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (27455.*R.^{34}.*R.*Z5^2*S^2*Z5^{32}*(S_v)^2)/(72057594037927936*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (108205.*R.^{35}.*R.*Z5*S^2*Z5^{33}*(S_v)^2)/(9007199254740992*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (105030792781.*R.^{36}*S^2*Z5^{34}*(S_v)^2)/(3458764513820540928*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (855.*R.^{36}.*R.*Z5^2*S^2*Z5^{34}*(S_v)^2)/(72057594037927936*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.*Z5*S^2*Z5^{35}*(S_v)^2)/(1729382256910270464*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (548568674633.*R.^{38}*S^2*Z5^{36}*(S_v)^2)/... \\
& (110680464442257309696*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (1805.*R.^{38}.*R.*Z5^2*S^2*Z5^{36}*(S_v)^2)/(6917529027641081856*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.*Z5*S^2*Z5^{37}*(S_v)^2)/(13835058055282163712*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (10322387501.*R.^{40}*S^2*Z5^{38}*(S_v)^2)/... \\
& (13835058055282163712*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (25.*R.^{40}.*R.*Z5^2*S^2*Z5^{38}*(S_v)^2)/(6917529027641081856*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.*Z5*S^2*Z5^{39}*(S_v)^2)/(55340232221128654848*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (1462601471251.*R.^{42}*S^2*Z5^{40}*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (7.*R.^{42}.*R.*Z5^2*S^2*Z5^{40}*(S_v)^2)/(295147905179352825856*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.*Z5*S^2*Z5^{41}*(S_v)^2)/(1328165573307087716352*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (185335180013.*R.^{44}*S^2*Z5^{42}*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (3115.*R.^{45}.*R.*Z5*S^2*Z5^{43}*(S_v)^2)/(21250649172913403461632*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}*S^2*Z5^{44}*(S_v)^2)/(1360041547066457821544448*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (49.*R.^{47}.*R.*Z5*S^2*Z5^{45}*(S_v)^2)/(56668397794435742564352*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (24026340573.*R.^{48}*S^2*Z5^{46}*(S_v)^2)/... \\
& (151115727451828646838272*(1 + Z5^{2/4} + Z5^{4/64})^4) + \\
& (5273670271697.*R.^{50}*S^2*Z5^{48}*(S_v)^2)/(348170636049013202315378688*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (37823055319.*R.^{52}*S^2*Z5^{50}*(S_v)^2)/(29014219670751100192948224*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (31266829573.*R.^{54}*S^2*Z5^{52}*(S_v)^2)/(309485009821345068724781056*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (305764487.*R.^{56}*S^2*Z5^{54}*(S_v)^2)/(43521329506126650289422336*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (155671821505.*R.^{58}*S^2*Z5^{56}*(S_v)^2)/(356526731314189519170947776512*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (8605263625.*R.^{60}*S^2*Z5^{58}*(S_v)^2)/(356526731314189519170947776512*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (4487015167.*R.^{62}*S^2*Z5^{60}*(S_v)^2)/(3802951800684688204490109616128*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots \\
& (64197131.*R.^{64}*S^2*Z5^{62}*(S_v)^2)/(1267650600228229401496703205376*(1 + Z5^{2/4} + Z5^{4/64})^4) + \dots
\end{aligned}$$

```

(7366421503.*R.^66*S^2*Z5^64*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z5^2/4 + Z5^4/64)^4) +
(118374655.*R.^68*S^2*Z5^66*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z5^2/4 + Z5^4/64)^4) +
(103217975.*R.^70*S^2*Z5^68*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z5^2/4 + Z5^4/64)^4) +
(1169089.*R.^72*S^2*Z5^70*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z5^2/4 + Z5^4/64)^4) +
(16453715.*R.^74*S^2*Z5^72*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z5^2/4 + Z5^4/64)^4) +
(234365.*R.^76*S^2*Z5^74*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z5^2/4 + Z5^4/64)^4) +
(77905.*R.^78*S^2*Z5^76*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z5^2/4 + Z5^4/64)^4) +
(175.*R.^80*S^2*Z5^78*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z5^2/4 + Z5^4/64)^4) +
(49.*R.^82*S^2*Z5^80*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z5^2/4 + Z5^4/64)^4);

```

```

Ns5=Nf5+Nc+Nr5;
Phi5=Nf5./[Nc+Nr5];
Be5=1./[1+Phi5];
Gf5=Nf5./Ns5;
Gr5=[Nr5]./Ns5;
Nh5=Nc+Nr5;

```

```

plot(R,Ns1,'b',R,Ns2,'g',R,Ns3,'r',R,Ns4,'k',R,Ns5,'m')

% plot(R,Be1,'b',R,Be2,'g',R,Be3,'r',R,Be4,'k',R,Be5,'m')

% plot(R,Phi1,'b',R,Phi2,'g',R,Phi3,'r',R,Phi4,'k',R,Phi5,'m')

% plot(R,Gf1,'b',R,Gf2,'g',R,Gf3,'r',R,Gf4,'k',R,Gf5,'m')

% plot(R,Gr1,'b',R,Gr2,'g',R,Gr3,'r',R,Gr4,'k',R,Gr5,'m')

% plot(R,Nf1,'b',R,Nf2,'g',R,Nf3,'r',R,Nf4,'k',R,Nf5,'m')

% plot(R,Nh1,'b',R,Nh2,'g',R,Nh3,'r',R,Nh4,'k',R,Nh5,'m')

% % % % % plot(Nh1,Nf1,'b',Nh2,Nf2,'g',Nh3,Nf3,'r',Nh4,Nf4,'k',Nh5,Nf5,'m')

```

PLOTTOOLS ON

**2.3. Distribution of  $N_s$ ,  $Be$ ,  $\Phi$ ,  $G_F$ ,  $G_R$ ,  $N_C$  and  $N_H$  versus  $Y$  for a range of  $Pe$  and set of  $S$ ,  $S_v$ ,  $Z$  &  $Br$**

```

S=1; S_v=1; Z=1; Br=1;
% S=5; S_v=0.75; Z=7.5; Br=0.4;
% % % % S=2; S_v=1; Z=5; Br=0.2;
% % % % S=25; S_v=15; Z=10; Br=0.4;
% % % % S=20; S_v=2; Z=2.5; Br=0.6;
% % % % S=10; S_v=25; Z=20; Br=0.5;

q=1.86;
s=1;
Dh=250*10^-6;
R=0:0.005:1;

Nf=Br*[(1024.*R.^2.*Z^4 + 256.*R.^4.*Z^6 + 16.*R.^6.*Z^8)/(4096 + 2048*Z^2 + 384*Z^4 + 32*Z^6 + Z^8)];

```

$$Nr = \begin{aligned} & (R.^2*S.^2)/4 + (25.*R.^2*S.^2*(S_v))/(384*(1 + Z^2/4 + Z^4/64)^2) + Z^2/4 + Z^4/64)^2) + \\ & (R.^2.*R.^2*S.^2*(S_v))/(4*(1 + Z^2/4 + Z^4/64)^2) - ... \\ & (43.*R.^4*S.^2*Z.^2*(S_v))/(384*(1 + Z^2/4 + Z^4/64)^2) - ... \\ & + (5.*R.^5.*R.^2*Z.^2*Z.^3*(S_v))/(32*(1 + Z^2/4 + Z^4/64)^2) + (407.*R.^6*S.^2*Z.^4*(S_v))/(4096*(1 + Z^2/4 + Z^4/64)^2) + ... \\ & (7.*R.^7.*R.^2*Z.^2*Z.^5*(S_v))/(768*(1 + Z^2/4 + Z^4/64)^2) + (539.*R.^8*S.^2*Z.^6*(S_v))/(4096*(1 + Z^2/4 + Z^4/64)^2) + ... \\ & (85225.*R.^10*S.^2*Z.^8*(S_v))/(1572864*(1 + Z^2/4 + Z^4/64)^2) + Z^2/4 + Z^4/64)^2) + \\ & (6487.*R.^12*S.^2*Z.^10*(S_v))/(393216*(1 + Z^2/4 + Z^4/64)^2) + ... \\ & (17773.*R.^14*S.^2*Z.^12*(S_v))/(4194304*(1 + Z^2/4 + Z^4/64)^2) + Z^2/4 + Z^4/64)^2) + \\ & (2011.*R.^16*S.^2*Z.^14*(S_v))/(2097152*(1 + Z^2/4 + Z^4/64)^2) + ... \\ & (206775.*R.^18*S.^2*Z.^16*(S_v))/(1073741824*(1 + Z^2/4 + Z^4/64)^2) + Z^2/4 + Z^4/64)^2) + \\ & (108275.*R.^20*S.^2*Z.^18*(S_v))/(3221225472*(1 + Z^2/4 + Z^4/64)^2) + ... \\ & (512435.*R.^22*S.^2*Z.^20*(S_v))/(103079215104*(1 + Z^2/4 + Z^4/64)^2) + Z^2/4 + Z^4/64)^2) + \\ & (21031.*R.^24*S.^2*Z.^22*(S_v))/(34359738368*(1 + Z^2/4 + Z^4/64)^2) + ... \\ & (272987.*R.^26*S.^2*Z.^24*(S_v))/(4398046511104*(1 + Z^2/4 + Z^4/64)^2) + Z^2/4 + Z^4/64)^2) + \\ & (11305.*R.^28*S.^2*Z.^26*(S_v))/(2199023255552*(1 + Z^2/4 + Z^4/64)^2) + ... \\ & (24225.*R.^30*S.^2*Z.^28*(S_v))/(70368744177664*(1 + Z^2/4 + Z^4/64)^2) + Z^2/4 + Z^4/64)^2) + \\ & (323.*R.^32*S.^2*Z.^30*(S_v))/(17592186044416*(1 + Z^2/4 + Z^4/64)^2) + ... \\ & (27455.*R.^34*S.^2*Z.^32*(S_v))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + Z^2/4 + Z^4/64)^2) + \\ & (855.*R.^36*S.^2*Z.^34*(S_v))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + ... \\ & (1805.*R.^38*S.^2*Z.^36*(S_v))/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^2) + Z^2/4 + Z^4/64)^2) + \\ & (25.*R.^40*S.^2*Z.^38*(S_v))/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^2) + ... \\ & (7.*R.^42*S.^2*Z.^40*(S_v))/(147573952589676412928*(1 + Z^2/4 + Z^4/64)^2) + Z^2/4 + Z^4/64)^2) + \\ & (625.*R.^2*S.^2*(S_v)^2)/(147456*(1 + Z^2/4 + Z^4/64)^4) + ... \\ & (25.*R.^2.*R.^2*Z.^2*(S_v)^2)/(768*(1 + Z^2/4 + Z^4/64)^4) + (R.^2.*R.^2*Z.^4*S.^2*(S_v)^2)/(16*(1 + Z^2/4 + Z^4/64)^4) - ... \\ & (1075.*R.^4*S.^2*Z.^2*(S_v)^2)/(73728*(1 + Z^2/4 + Z^4/64)^4) + Z^2/4 + Z^4/64)^4) - \\ & (43.*R.^4.*R.^2*Z.^2*Z.^2*(S_v)^2)/(768*(1 + Z^2/4 + Z^4/64)^4) + ... \\ & (125.*R.^5.*R.^2*Z.^2*Z.^3*(S_v)^2)/(6144*(1 + Z^2/4 + Z^4/64)^4) + Z^2/4 + Z^4/64)^4) + ... \\ & (5.*R.^5.*R.^2*Z.^3*S.^2*Z.^3*(S_v)^2)/(64*(1 + Z^2/4 + Z^4/64)^4) + ... \end{aligned}$$

$$\begin{aligned}
& (60109.*R.^6*S^2*Z^4*(S_v)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (407.*R.^6.*R.*Z^2*S^2*Z^4*(S_v)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) - \\
& (4985.*R.^7.*R.*Z^2*S^2*Z^5*(S_v)^2)/(147456*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (7.*R.^7.*R.*Z^3*S^2*Z^5*(S_v)^2)/(1536*(1 + Z^{2/4} + Z^{4/64})^4) - \\
& (671.*R.^8*S^2*Z^6*(S_v)^2)/(131072*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (739.*R.^8.*R.*Z^2*S^2*Z^6*(S_v)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (17111.*R.^9.*R.*Z^2*S^2*Z^7*(S_v)^2)/(589824*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (3787661.*R.^10*S^2*Z^8*(S_v)^2)/(301989888*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (31395.*R.^10.*R.*Z^2*S^2*Z^8*(S_v)^2)/(1048576*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (67529.*R.^11.*R.*Z^2*S^2*Z^9*(S_v)^2)/(1572864*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1627151.*R.^12.*R.*Z^2*S^2*Z^10*(S_v)^2)/(100663296*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (19657.*R.^12.*R.*Z^2*S^2*Z^10*(S_v)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (486493.*R.^13.*R.*Z^2*S^2*Z^11*(S_v)^2)/(25165824*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (241027273.*R.^14*S^2*Z^12*(S_v)^2)/(9663676416*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (17773.*R.^14.*R.*Z^2*S^2*Z^12*(S_v)^2)/(8388608*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (3710335.*R.^15.*R.*Z^2*S^2*Z^13*(S_v)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (53842355.*R.^16*S^2*Z^14*(S_v)^2)/(3221225472*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (2011.*R.^16.*R.*Z^2*S^2*Z^14*(S_v)^2)/(4194304*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (981421.*R.^17.*R.*Z^2*S^2*Z^15*(S_v)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (19618549477.*R.^18*S^2*Z^16*(S_v)^2)/(2473901162496*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (206775.*R.^18.*R.*Z^2*S^2*Z^16*(S_v)^2)/(2147483648*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (607051.*R.^19.*R.*Z^2*S^2*Z^17*(S_v)^2)/(1610612736*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (944668661.*R.^20*S^2*Z^18*(S_v)^2)/(309237645312*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (108275.*R.^20.*R.*Z^2*S^2*Z^18*(S_v)^2)/(6442450944*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (4002553.*R.^21.*R.*Z^2*S^2*Z^19*(S_v)^2)/(51539607552*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (3348433219.*R.^22*S^2*Z^20*(S_v)^2)/(3298534883328*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (512435.*R.^22.*R.*Z^2*S^2*Z^20*(S_v)^2)/(206158430208*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (5778425.*R.^23.*R.*Z^2*S^2*Z^21*(S_v)^2)/(412316860416*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1484626111.*R.^24*S^2*Z^22*(S_v)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (21031.*R.^24.*R.*Z^2*S^2*Z^22*(S_v)^2)/(68719476736*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (10718225.*R.^25.*R.*Z^2*S^2*Z^23*(S_v)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (33848465467.*R.^26*S^2*Z^24*(S_v)^2)/(422212465065984*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (272987.*R.^26.*R.*Z^2*S^2*Z^24*(S_v)^2)/(8796093022208*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (11158205.*R.^27.*R.*Z^2*S^2*Z^25*(S_v)^2)/(39582418599936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24750045961.*R.^28*S^2*Z^26*(S_v)^2)/(1266637395197952*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (11305.*R.^28.*R.*Z^2*S^2*Z^26*(S_v)^2)/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (6450277.*R.^29.*R.*Z^2*S^2*Z^27*(S_v)^2)/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (59064594011.*R.^30*S^2*Z^28*(S_v)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24225.*R.^30.*R.*Z^2*S^2*Z^28*(S_v)^2)/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (4624109.*R.^31.*R.*Z^2*S^2*Z^29*(S_v)^2)/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (36553306561.*R.^32*S^2*Z^30*(S_v)^2)/(40532396646334464*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (323.*R.^32.*R.*Z^2*S^2*Z^30*(S_v)^2)/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (679915.*R.^33.*R.*Z^2*S^2*Z^31*(S_v)^2)/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (1189947216611.*R.^34*S^2*Z^32*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (27455.*R.^34.*R.*Z^2*S^2*Z^32*(S_v)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (108205.*R.^35.*R.*Z^2*S^2*Z^33*(S_v)^2)/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (105030792781.*R.^36*S^2*Z^34*(S_v)^2)/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (855.*R.^36.*R.*Z^2*S^2*Z^34*(S_v)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (990641.*R.^37.*R.*Z^2*S^2*Z^35*(S_v)^2)/(1729382256910270464*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (548568674633.*R.^38*S^2*Z^36*(S_v)^2)/... \\
& (110680464442257309696*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (1805.*R.^38.*R.*Z^2*S^2*Z^36*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (294785.*R.^39.*R.*Z^2*S^2*Z^37*(S_v)^2)/(13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (10322387501.*R.^40*S^2*Z^38*(S_v)^2)/... \\
& (13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (25.*R.^40.*R.*Z^2*S^2*Z^38*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + ...
\end{aligned}$$

$$\begin{aligned}
& (32965.*R.^41.*R.*Z*S^2*Z^39*(S_v)^2)/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1462601471251.*R.^42*S^2*Z^40*(S_v)^2)/... \\
& \quad (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^42.*R.*Z^2*S^2*Z^40*(S_v)^2)/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (15635.*R.^43.*R.*Z*S^2*Z^41*(S_v)^2)/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^44*S^2*Z^42*(S_v)^2)/... \\
& \quad (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3115.*R.^45.*R.*Z*S^2*Z^43*(S_v)^2)/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (2057042720599.*R.^46*S^2*Z^44*(S_v)^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& ... \\
& (49.*R.^47.*R.*Z*S^2*Z^45*(S_v)^2)/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^48*S^2*Z^46*(S_v)^2)/... \\
& \quad (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5273670271697.*R.^50*S^2*Z^48*(S_v)^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& ... \\
& (37823055319.*R.^52*S^2*Z^50*(S_v)^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& ... \\
& (31266829573.*R.^54*S^2*Z^52*(S_v)^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& ... \\
& (305764487.*R.^56*S^2*Z^54*(S_v)^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (155671821505.*R.^58*S^2*Z^56*(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (8605263625.*R.^60*S^2*Z^58*(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (4487015167.*R.^62*S^2*Z^60*(S_v)^2)/(3802951800684688204490109616128*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (64197131.*R.^64*S^2*Z^62*(S_v)^2)/(1267650600228229401496703205376*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (7366421503.*R.^66*S^2*Z^64*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (118374655.*R.^68*S^2*Z^66*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (103217975.*R.^70*S^2*Z^68*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (1169089.*R.^72*S^2*Z^70*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (16453715.*R.^74*S^2*Z^72*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (234365.*R.^76*S^2*Z^74*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (77905.*R.^78*S^2*Z^76*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (175.*R.^80*S^2*Z^78*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (49.*R.^82*S^2*Z^80*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z^{2/4} + Z^{4/64})^4);
\end{aligned}$$

Pe1=2;

Nc1=[1./Pe1^2]\*[16\*q^2+s^2\*Dh^2+8\*q\*s\*Dh];

Ns1=Nf+Nc1+Nr;

Phi1=Nf./[Nc1+Nr];

Be1=1./[1+Phi1];

Gf1=Nf./Ns1;

Gr1=[Nr]./Ns1;

Nh1=Nc1+Nr;

```

Pe2=4;
Nc2=[1./Pe2^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Ns2=Nf+Nc2+Nr;
Phi2=Nf./[Nc2+Nr];
Be2=1./[1+Phi2];
Gf2=Nf./Ns2;
Gr2=[Nr]./Ns2;
Nh2=Nc2+Nr;

Pe3=6;
Nc3=[1./Pe3^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Ns3=Nf+Nc3+Nr;
Phi3=Nf./[Nc3+Nr];
Be3=1./[1+Phi3];
Gf3=Nf./Ns3;
Gr3=[Nr]./Ns3;
Nh3=Nc3+Nr;

Pe4=8;
Nc4=[1./Pe4^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Ns4=Nf+Nc4+Nr;
Phi4=Nf./[Nc4+Nr];
Be4=1./[1+Phi4];
Gf4=Nf./Ns4;
Gr4=[Nr]./Ns4;
Nh4=Nc4+Nr;

Pe5=10;
Nc5=[1./Pe5^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];
Ns5=Nf+Nc5+Nr;
Phi5=Nf./[Nc5+Nr];
Be5=1./[1+Phi5];
Gf5=Nf./Ns5;
Gr5=[Nr]./Ns5;
Nh5=Nc5+Nr;

plot(R,Ns1,'b',R,Ns2,'g',R,Ns3,'r',R,Ns4,'k',R,Ns5,'m')
% plot(R,Be1,'b',R,Be2,'g',R,Be3,'r',R,Be4,'k',R,Be5,'m')
% plot(R,Phi1,'b',R,Phi2,'g',R,Phi3,'r',R,Phi4,'k',R,Phi5,'m')
% plot(R,Gf1,'b',R,Gf2,'g',R,Gf3,'r',R,Gf4,'k',R,Gf5,'m')
% plot(R,Gr1,'b',R,Gr2,'g',R,Gr3,'r',R,Gr4,'k',R,Gr5,'m')
% plot(R,Nc1,'b',R,Nc2,'g',R,Nc3,'r',R,Nc4,'k',R,Nc5,'m')
% plot(R,Nh1,'b',R,Nh2,'g',R,Nh3,'r',R,Nh4,'k',R,Nh5,'m')


```

PLOTOOLS ON

**2.4. Distribution of  $N_s$ ,  $Be$ ,  $\Phi$ ,  $G_F$ ,  $G_R$ ,  $N_F$  and  $N_H$  versus  $Y$  for a range of  $S$  and set of  $S_v$ ,  $Z$ ,  $Br$  &  $Pe$**

```

S_v=1; Z=1; Br=1; Pe=10;
% S_v=2.5; Z=2; Br=0.5; Pe=5;

% % % % Z=4; S_v=10; Br=0.6; Pe=8;
% % % % Z=5; S_v=0.75; Br=0.2; Pe=2;
% % % % Z=10; S_v=5; Br=1; Pe=7.5;
% % % % Z=20; S_v=15; Br=0.9; Pe=10;

q=1.86;
s=1;
Dh=250*10^-6;
R=0:0.005:1;

Nc=[1/Pe^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];

```

S1=1;

Nf1=Br\*[(Z^2).\*exp(-2.\*R.\*Z)+(Z^2)\*exp(-2\*Z)-2\*Z^2.\*exp(-Z-R.\*Z)];

Nr1=(R.^2\*S1.^2)/4 + (25.\*R.^2\*S1.^2\*(S\_v))/(384\*(1 + Z^2/4 + Z^4/64)^2)+

(R.^2.\*R.\*Z^2\*S1.^2\*(S\_v))/(4\*(1 + Z^2/4 + Z^4/64)^2) - ...

(43.\*R.^4\*S1.^2\*Z^2\*(S\_v))/(384\*(1 + Z^2/4 + Z^4/64)^2) ...

+ (5.\*R.^5.\*R.\*Z\*S1.^2\*Z^3\*(S\_v))/(32\*(1 + Z^2/4 + Z^4/64)^2) +

(407.\*R.^6\*S1.^2\*Z^4\*(S\_v))/(4096\*(1 + Z^2/4 + Z^4/64)^2) + ...

(7.\*R.^7.\*R.\*Z\*S1.^2\*Z^5\*(S\_v))/(768\*(1 + Z^2/4 + Z^4/64)^2) +

(539.\*R.^8\*S1.^2\*Z^6\*(S\_v))/(4096\*(1 + Z^2/4 + Z^4/64)^2) + ...

(85225.\*R.^10\*S1.^2\*Z^8\*(S\_v))/(1572864\*(1 + Z^2/4 + Z^4/64)^2) + ...

(6487.\*R.^12\*S1.^2\*Z^10\*(S\_v))/(393216\*(1 + Z^2/4 + Z^4/64)^2) + ...

(17773.\*R.^14\*S1.^2\*Z^12\*(S\_v))/(4194304\*(1 + Z^2/4 + Z^4/64)^2) +

(2011.\*R.^16\*S1.^2\*Z^14\*(S\_v))/(2097152\*(1 + Z^2/4 + Z^4/64)^2) + ...

(206775.\*R.^18\*S1.^2\*Z^16\*(S\_v))/(1073741824\*(1 + Z^2/4 + Z^4/64)^2) +

(108275.\*R.^20\*S1.^2\*Z^18\*(S\_v))/(3221225472\*(1 + Z^2/4 + Z^4/64)^2) + ...

(512435.\*R.^22\*S1.^2\*Z^20\*(S\_v))/(103079215104\*(1 + Z^2/4 + Z^4/64)^2) +

(21031.\*R.^24\*S1.^2\*Z^22\*(S\_v))/(34359738368\*(1 + Z^2/4 + Z^4/64)^2) + ...

(272987.\*R.^26\*S1.^2\*Z^24\*(S\_v))/(4398046511104\*(1 + Z^2/4 + Z^4/64)^2) +

(11305.\*R.^28\*S1.^2\*Z^26\*(S\_v))/(2199023255552\*(1 + Z^2/4 + Z^4/64)^2) + ...

(24225.\*R.^30\*S1.^2\*Z^28\*(S\_v))/(70368744177664\*(1 + Z^2/4 + Z^4/64)^2) +

(323.\*R.^32\*S1.^2\*Z^30\*(S\_v))/(17592186044416\*(1 + Z^2/4 + Z^4/64)^2) + ...

(27455.\*R.^34\*S1.^2\*Z^32\*(S\_v))/(36028797018963968\*(1 + Z^2/4 + Z^4/64)^2) +

(855.\*R.^36\*S1.^2\*Z^34\*(S\_v))/(36028797018963968\*(1 + Z^2/4 + Z^4/64)^2) + ...

(1805.\*R.^38\*S1.^2\*Z^36\*(S\_v))/(3458764513820540928\*(1 + Z^2/4 + Z^4/64)^2) +

(25.\*R.^40\*S1.^2\*Z^38\*(S\_v))/(3458764513820540928\*(1 + Z^2/4 + Z^4/64)^2) + ...

(7.\*R.^42\*S1.^2\*Z^40\*(S\_v))/(147573952589676412928\*(1 + Z^2/4 + Z^4/64)^2) +

(625.\*R.^2\*S1.^2\*(S\_v)^2)/(147456\*(1 + Z^2/4 + Z^4/64)^4) + ...

(25.\*R.^2.\*R.\*Z^2\*S1.^2\*(S\_v)^2)/(768\*(1 + Z^2/4 + Z^4/64)^4) +

(R.^2.\*R.\*Z^4\*S1.^2\*(S\_v)^2)/(16\*(1 + Z^2/4 + Z^4/64)^4) - ...

(1075.\*R.^4\*S1.^2\*Z^2\*(S\_v)^2)/(73728\*(1 + Z^2/4 + Z^4/64)^4) + ...

(43.\*R.^4.\*R.\*Z^2\*S1.^2\*Z^2\*(S\_v)^2)/(768\*(1 + Z^2/4 + Z^4/64)^4) + ...

$$\begin{aligned}
& (125.*R.^5.*R.^*Z*S1^2*Z^3*(S_v)^2)/(6144*(1 + Z^2/4 + Z^4/64)^4) + \\
& (5.*R.^5.*R.^*Z^3*S1^2*Z^3*(S_v)^2)/(64*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (60109.*R.^6.*S1^2*Z^4*(S_v)^2)/(2359296*(1 + Z^2/4 + Z^4/64)^4) + \\
& (407.*R.^6.*R.^*Z^2*S1^2*Z^4*(S_v)^2)/(8192*(1 + Z^2/4 + Z^4/64)^4) - \dots \\
& (4985.*R.^7.*R.^*Z*S1^2*Z^5*(S_v)^2)/(147456*(1 + Z^2/4 + Z^4/64)^4) + \\
& (7.*R.^7.*R.^*Z^3*S1^2*Z^5*(S_v)^2)/(1536*(1 + Z^2/4 + Z^4/64)^4) - \dots \\
& (671.*R.^8.*S1^2*Z^6*(S_v)^2)/(131072*(1 + Z^2/4 + Z^4/64)^4) + \\
& (739.*R.^8.*R.^*Z^2*S1^2*Z^6*(S_v)^2)/(8192*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (17111.*R.^9.*R.^*Z*S1^2*Z^7*(S_v)^2)/(589824*(1 + Z^2/4 + Z^4/64)^4) - \\
& (3787661.*R.^10.*S1^2*Z^8*(S_v)^2)/(301989888*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (31395.*R.^10.*R.^*Z^2*S1^2*Z^8*(S_v)^2)/(1048576*(1 + Z^2/4 + Z^4/64)^4) + \\
& (67529.*R.^11.*R.^*Z*S1^2*Z^9*(S_v)^2)/(1572864*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (1627151.*R.^12*S1^2*Z^10*(S_v)^2)/(100663296*(1 + Z^2/4 + Z^4/64)^4) + \\
& (19657.*R.^12.*R.^*Z^2*S1^2*Z^10*(S_v)^2)/(2359296*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (486493.*R.^13.*R.^*Z*S1^2*Z^11*(S_v)^2)/(25165824*(1 + Z^2/4 + Z^4/64)^4) + \\
& (241027273.*R.^14*S1^2*Z^12*(S_v)^2)/(9663676416*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (17773.*R.^14.*R.^*Z^2*S1^2*Z^12*(S_v)^2)/(8388608*(1 + Z^2/4 + Z^4/64)^4) + \\
& (3710335.*R.^15.*R.^*Z*S1^2*Z^13*(S_v)^2)/(603979776*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (53842355.*R.^16.*S1^2*Z^14*(S_v)^2)/(3221225472*(1 + Z^2/4 + Z^4/64)^4) + \\
& (2011.*R.^16.*R.^*Z^2*S1^2*Z^14*(S_v)^2)/(4194304*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (981421.*R.^17.*R.^*Z*S1^2*Z^15*(S_v)^2)/(603979776*(1 + Z^2/4 + Z^4/64)^4) + \\
& (19618549477.*R.^18*S1^2*Z^16*(S_v)^2)/(2473901162496*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (206775.*R.^18.*R.^*Z^2*S1^2*Z^16*(S_v)^2)/(2147483648*(1 + Z^2/4 + Z^4/64)^4) + \\
& (607051.*R.^19.*R.^*Z*S1^2*Z^17*(S_v)^2)/(1610612736*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (944668661.*R.^20*S1^2*Z^18*(S_v)^2)/(309237645312*(1 + Z^2/4 + Z^4/64)^4) + \\
& (108275.*R.^20.*R.^*Z^2*S1^2*Z^18*(S_v)^2)/(6442450944*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (4002553.*R.^21.*R.^*Z*S1^2*Z^19*(S_v)^2)/(51539607552*(1 + Z^2/4 + Z^4/64)^4) + \\
& (3348433219.*R.^22*S1^2*Z^20*(S_v)^2)/(3298534883328*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (512435.*R.^22.*R.^*Z^2*S1^2*Z^20*(S_v)^2)/(206158430208*(1 + Z^2/4 + Z^4/64)^4) + \\
& (5778425.*R.^23.*R.^*Z*S1^2*Z^21*(S_v)^2)/(412316860416*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (1484626111.*R.^24*S1^2*Z^22*(S_v)^2)/(4947802324992*(1 + Z^2/4 + Z^4/64)^4) + \\
& (21031.*R.^24.*R.^*Z^2*S1^2*Z^22*(S_v)^2)/(68719476736*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (10718225.*R.^25.*R.^*Z*S1^2*Z^23*(S_v)^2)/(4947802324992*(1 + Z^2/4 + Z^4/64)^4) + \\
& (33848465467.*R.^26*S1^2*Z^24*(S_v)^2)/(422212465065984*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (272987.*R.^26.*R.^*Z^2*S1^2*Z^24*(S_v)^2)/(8796093022208*(1 + Z^2/4 + Z^4/64)^4) + \\
& (11158205.*R.^27.*R.^*Z*S1^2*Z^25*(S_v)^2)/(39582418599936*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (24750045961.*R.^28*S1^2*Z^26*(S_v)^2)/(1266637395197952*(1 + Z^2/4 + Z^4/64)^4) + \\
& (11305.*R.^28.*R.^*Z^2*S1^2*Z^26*(S_v)^2)/(4398046511104*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (6450277.*R.^29.*R.^*Z*S1^2*Z^27*(S_v)^2)/(211106232532992*(1 + Z^2/4 + Z^4/64)^4) + \\
& (59064594011.*R.^30*S1^2*Z^28*(S_v)^2)/(13510798882111488*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (24225.*R.^30.*R.^*Z^2*S1^2*Z^28*(S_v)^2)/(140737488355328*(1 + Z^2/4 + Z^4/64)^4) + \\
& (4624109.*R.^31.*R.^*Z*S1^2*Z^29*(S_v)^2)/(1688849860263936*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (36553306561.*R.^32*S1^2*Z^30*(S_v)^2)/(40532396464334464*(1 + Z^2/4 + Z^4/64)^4) + \\
& (323.*R.^32.*R.^*Z^2*S1^2*Z^30*(S_v)^2)/(35184372088832*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (679915.*R.^33.*R.^*Z*S1^2*Z^31*(S_v)^2)/(3377699720527872*(1 + Z^2/4 + Z^4/64)^4) + \\
& (1189947216611.*R.^34*S1^2*Z^32*(S_v)^2)/(6917529027641081856*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (27455.*R.^34.*R.^*Z^2*S1^2*Z^32*(S_v)^2)/(72057594037927936*(1 + Z^2/4 + Z^4/64)^4) + \\
& (108205.*R.^35.*R.^*Z*S1^2*Z^33*(S_v)^2)/(9007199254740992*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (105030792781.*R.^36*S1^2*Z^34*(S_v)^2)/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^4) + \\
& (855.*R.^36.*R.^*Z^2*S1^2*Z^34*(S_v)^2)/(72057594037927936*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (990641.*R.^37.*R.^*Z*S1^2*Z^35*(S_v)^2)/(1729382256910270464*(1 + Z^2/4 + Z^4/64)^4) + \\
& (548568674633.*R.^38*S1^2*Z^36*(S_v)^2)/... \\
& (110680464442257309696*(1 + Z^2/4 + Z^4/64)^4) + \\
& (1805.*R.^38.*R.^*Z^2*S1^2*Z^36*(S_v)^2)/(6917529027641081856*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (294785.*R.^39.*R.^*Z*S1^2*Z^37*(S_v)^2)/(13835058055282163712*(1 + Z^2/4 + Z^4/64)^4) + \\
& (10322387501.*R.^40*S1^2*Z^38*(S_v)^2)/...
\end{aligned}$$

$$\begin{aligned}
& (13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (25.*R.^{40}.*R.*Z^2*S1^2*Z^38*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (32965.*R.^{41}.*R.*Z*S1^2*Z^39*(S_v)^2)/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1462601471251.*R.^{42}*S1^2*Z^40*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (7.*R.^{42}.*R.*Z^2*S1^2*Z^40*(S_v)^2)/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (15635.*R.^{43}.*R.*Z*S1^2*Z^41*(S_v)^2)/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^{44}*S1^2*Z^42*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (3115.*R.^{45}.*R.*Z*S1^2*Z^43*(S_v)^2)/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (2057042720599.*R.^{46}*S1^2*Z^44*(S_v)^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) \\
& + ... \\
& (49.*R.^{47}.*R.*Z*S1^2*Z^45*(S_v)^2)/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^{48}*S1^2*Z^46*(S_v)^2)/... \\
& (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (5273670271697.*R.^{50}*S1^2*Z^48*(S_v)^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (37823055319.*R.^{52}*S1^2*Z^50*(S_v)^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (31266829573.*R.^{54}*S1^2*Z^52*(S_v)^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (305764487.*R.^{56}*S1^2*Z^54*(S_v)^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (155671821505.*R.^{58}*S1^2*Z^56*(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (8605263625.*R.^{60}*S1^2*Z^58*(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (4487015167.*R.^{62}*S1^2*Z^60*(S_v)^2)/(3802951800684688204490109616128*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (64197131.*R.^{64}*S1^2*Z^62*(S_v)^2)/(1267650600228229401496703205376*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (7366421503.*R.^{66}*S1^2*Z^64*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (118374655.*R.^{68}*S1^2*Z^66*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (103217975.*R.^{70}*S1^2*Z^68*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (1169089.*R.^{72}*S1^2*Z^70*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (16453715.*R.^{74}*S1^2*Z^72*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (234365.*R.^{76}*S1^2*Z^74*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (77905.*R.^{78}*S1^2*Z^76*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (175.*R.^{80}*S1^2*Z^78*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (49.*R.^{82}*S1^2*Z^80*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z^{2/4} + Z^{4/64})^4); 
\end{aligned}$$

Ns1=Nf1+Nc+Nr1;  
 Phi1=Nf1./[Nc+Nr1];  
 Be1=1./[1+Phi1];  
 Gf1=Nf1./Ns1;  
 Gr1=[Nr1]./Ns1;  
 Nh1=Nc+Nr1;

S2=4;  
 Nf2=Br\*[(Z^2).\*exp(-2.\*R.\*Z)+(Z^2)\*exp(-2\*Z)-2\*Z^2.\*exp(-Z-R.\*Z)];  
 Nr2=(R.^2\*S2^2)/4 + (25.\*R.^2\*S2^2\*(S\_v))/(384\*(1 + Z^2/4 + Z^4/64)^2)+  
 (R.^2.\*R.\*Z^2\*S2^2\*(S\_v))/(4\*(1 + Z^2/4 + Z^4/64)^2) ...  
 (43.\*R.^4\*S2^2\*Z^2\*(S\_v))/(384\*(1 + Z^2/4 + Z^4/64)^2)...  
 + (5.\*R.^5.\*R.\*Z\*S2^2\*Z^3\*(S\_v))/(32\*(1 + Z^2/4 + Z^4/64)^2)+  
 (407.\*R.^6\*S2^2\*Z^4\*(S\_v))/(4096\*(1 + Z^2/4 + Z^4/64)^2) + ...  
 (7.\*R.^7.\*R.\*Z\*S2^2\*Z^5\*(S\_v))/(768\*(1 + Z^2/4 + Z^4/64)^2) +  
 (539.\*R.^8\*S2^2\*Z^6\*(S\_v))/(4096\*(1 + Z^2/4 + Z^4/64)^2) + ...  
 (85225.\*R.^10\*S2^2\*Z^8\*(S\_v))/(1572864\*(1 + Z^2/4 + Z^4/64)^2) +  
 (6487.\*R.^12\*S2^2\*Z^10\*(S\_v))/(393216\*(1 + Z^2/4 + Z^4/64)^2) + ...  
 (17773.\*R.^14\*S2^2\*Z^12\*(S\_v))/(4194304\*(1 + Z^2/4 + Z^4/64)^2) +  
 (2011.\*R.^16\*S2^2\*Z^14\*(S\_v))/(2097152\*(1 + Z^2/4 + Z^4/64)^2) + ...  
 (206775.\*R.^18\*S2^2\*Z^16\*(S\_v))/(1073741824\*(1 + Z^2/4 + Z^4/64)^2) +  
 (108275.\*R.^20\*S2^2\*Z^18\*(S\_v))/(3221225472\*(1 + Z^2/4 + Z^4/64)^2) + ...  
 (512435.\*R.^22\*S2^2\*Z^20\*(S\_v))/(103079215104\*(1 + Z^2/4 + Z^4/64)^2) +  
 (21031.\*R.^24\*S2^2\*Z^22\*(S\_v))/(34359738368\*(1 + Z^2/4 + Z^4/64)^2) + ...  
 (272987.\*R.^26\*S2^2\*Z^24\*(S\_v))/(4398046511104\*(1 + Z^2/4 + Z^4/64)^2) +  
 (11305.\*R.^28\*S2^2\*Z^26\*(S\_v))/(2199023255552\*(1 + Z^2/4 + Z^4/64)^2) + ...  
 (24225.\*R.^30\*S2^2\*Z^28\*(S\_v))/(70368744177664\*(1 + Z^2/4 + Z^4/64)^2) +  
 (323.\*R.^32\*S2^2\*Z^30\*(S\_v))/(17592186044416\*(1 + Z^2/4 + Z^4/64)^2) + ...  
 (27455.\*R.^34\*S2^2\*Z^32\*(S\_v))/(36028797018963968\*(1 + Z^2/4 + Z^4/64)^2) +  
 (855.\*R.^36\*S2^2\*Z^34\*(S\_v))/(36028797018963968\*(1 + Z^2/4 + Z^4/64)^2) + ...  
 (1805.\*R.^38\*S2^2\*Z^36\*(S\_v))/(3458764513820540928\*(1 + Z^2/4 + Z^4/64)^2) +  
 (25.\*R.^40\*S2^2\*Z^38\*(S\_v))/(3458764513820540928\*(1 + Z^2/4 + Z^4/64)^2) + ...  
 (7.\*R.^42\*S2^2\*Z^40\*(S\_v))/(147573952589676412928\*(1 + Z^2/4 + Z^4/64)^2) +  
 (625.\*R.^42\*S2^2\*(S\_v)^2)/(147456\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (25.\*R.^2.\*R.\*Z^2\*S2^2\*(S\_v)^2)/(768\*(1 + Z^2/4 + Z^4/64)^4) +  
 (R.^2.\*R.\*Z^4\*S2^2\*(S\_v)^2)/(16\*(1 + Z^2/4 + Z^4/64)^4) - ...  
 (1075.\*R.^4\*S2^2\*Z^2\*(S\_v)^2)/(73728\*(1 + Z^2/4 + Z^4/64)^4) -  
 (43.\*R.^4.\*R.\*Z^2\*S2^2\*Z^2\*(S\_v)^2)/(768\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (125.\*R.^5.\*R.\*Z^2\*S2^2\*Z^3\*(S\_v)^2)/(6144\*(1 + Z^2/4 + Z^4/64)^4) +  
 (5.\*R.^5.\*R.\*Z^3\*S2^2\*Z^3\*(S\_v)^2)/(64\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (60109.\*R.^6\*S2^2\*Z^4\*(S\_v)^2)/(2359296\*(1 + Z^2/4 + Z^4/64)^4) +  
 (407.\*R.^6.\*R.\*Z^2\*S2^2\*Z^4\*(S\_v)^2)/(8192\*(1 + Z^2/4 + Z^4/64)^4) - ...  
 (4985.\*R.^7.\*R.\*Z^2\*S2^2\*Z^5\*(S\_v)^2)/(147456\*(1 + Z^2/4 + Z^4/64)^4) +  
 (7.\*R.^7.\*R.\*Z^3\*S2^2\*Z^5\*(S\_v)^2)/(1536\*(1 + Z^2/4 + Z^4/64)^4) - ...  
 (671.\*R.^8\*S2^2\*Z^6\*(S\_v)^2)/(131072\*(1 + Z^2/4 + Z^4/64)^4) +  
 (739.\*R.^8.\*R.\*Z^2\*S2^2\*Z^6\*(S\_v)^2)/(8192\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (17111.\*R.^9.\*R.\*Z^2\*S2^2\*Z^7\*(S\_v)^2)/(589824\*(1 + Z^2/4 + Z^4/64)^4) -  
 (3787661.\*R.^10\*S2^2\*Z^8\*(S\_v)^2)/(301989888\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (31395.\*R.^10.\*R.\*Z^2\*S2^2\*Z^8\*(S\_v)^2)/(1048576\*(1 + Z^2/4 + Z^4/64)^4) +  
 (67529.\*R.^11.\*R.\*Z^2\*S2^2\*Z^9\*(S\_v)^2)/(1572864\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (1627151.\*R.^12\*S2^2\*Z^10\*(S\_v)^2)/(100663296\*(1 + Z^2/4 + Z^4/64)^4) +  
 (19657.\*R.^12.\*R.\*Z^2\*S2^2\*Z^10\*(S\_v)^2)/(2359296\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (486493.\*R.^13.\*R.\*Z^2\*S2^2\*Z^11\*(S\_v)^2)/(25165824\*(1 + Z^2/4 + Z^4/64)^4) +  
 (241027273.\*R.^14\*S2^2\*Z^12\*(S\_v)^2)/(9663676416\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (17773.\*R.^14.\*R.\*Z^2\*S2^2\*Z^12\*(S\_v)^2)/(8388608\*(1 + Z^2/4 + Z^4/64)^4) +  
 (3710335.\*R.^15.\*R.\*Z^2\*S2^2\*Z^13\*(S\_v)^2)/(603979776\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (53842355.\*R.^16\*S2^2\*Z^14\*(S\_v)^2)/(3221225472\*(1 + Z^2/4 + Z^4/64)^4) +  
 (2011.\*R.^16.\*R.\*Z^2\*S2^2\*Z^14\*(S\_v)^2)/(4194304\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (981421.\*R.^17.\*R.\*Z^2\*S2^2\*Z^15\*(S\_v)^2)/(603979776\*(1 + Z^2/4 + Z^4/64)^4) +  
 (19618549477.\*R.^18\*S2^2\*Z^16\*(S\_v)^2)/(2473901162496\*(1 + Z^2/4 + Z^4/64)^4) + ...  
 (206775.\*R.^18.\*R.\*Z^2\*S2^2\*Z^16\*(S\_v)^2)/(2147483648\*(1 + Z^2/4 + Z^4/64)^4) +  
 (607051.\*R.^19.\*R.\*Z^2\*S2^2\*Z^17\*(S\_v)^2)/(1610612736\*(1 + Z^2/4 + Z^4/64)^4) + ...

$$\begin{aligned}
& (944668661.*R.^{20}*S2^{2*Z^{18}}(S_v)^2)/(309237645312*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108275.*R.^{20}.*R.^{2*Z^{2*Z2^{2*Z^{18}}}(S_v)^2})/(6442450944*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4002553.*R.^{21}.*R.^{Z^{2*Z2^{2*Z^{19}}}(S_v)^2})/(51539607552*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3348433219.*R.^{22}*S2^{2*Z^{20}}(S_v)^2)/(3298534883328*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (512435.*R.^{22}.*R.^{Z^{2*Z2^{2*Z^{20}}}(S_v)^2})/(206158430208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5778425.*R.^{23}.*R.^{Z^{2*Z2^{2*Z^{21}}}(S_v)^2})/(412316860416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1484626111.*R.^{24}*S2^{2*Z^{22}}(S_v)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (21031.*R.^{24}.*R.^{Z^{2*Z2^{2*Z^{22}}}(S_v)^2})/(68719476736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (10718225.*R.^{25}.*R.^{Z^{2*Z2^{2*Z^{23}}}(S_v)^2})/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (33848465467.*R.^{26}*S2^{2*Z^{24}}(S_v)^2)/(422212465065984*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (272987.*R.^{26}.*R.^{Z^{2*Z2^{2*Z^{24}}}(S_v)^2})/(8796093022208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11158205.*R.^{27}.*R.^{Z^{2*Z2^{2*Z^{25}}}(S_v)^2})/(39582418599936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24750045961.*R.^{28}*S2^{2*Z^{26}}(S_v)^2)/(1266637395197952*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11305.*R.^{28}.*R.^{Z^{2*Z2^{2*Z^{26}}}(S_v)^2})/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (6450277.*R.^{29}.*R.^{Z^{2*Z2^{2*Z^{27}}}(S_v)^2})/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (59064594011.*R.^{30}*S2^{2*Z^{28}}(S_v)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24225.*R.^{30}.*R.^{Z^{2*Z2^{2*Z^{28}}}(S_v)^2})/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (4624109.*R.^{31}.*R.^{Z^{2*Z2^{2*Z^{29}}}(S_v)^2})/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (36553306561.*R.^{32}*S2^{2*Z^{30}}(S_v)^2)/(40532396464334464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (323.*R.^{32}.*R.^{Z^{2*Z2^{2*Z^{30}}}(S_v)^2})/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (679915.*R.^{33}.*R.^{Z^{2*Z2^{2*Z^{31}}}(S_v)^2})/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1189947216611.*R.^{34}*S2^{2*Z^{32}}(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (27455.*R.^{34}.*R.^{Z^{2*Z2^{2*Z^{32}}}(S_v)^2})/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108205.*R.^{35}.*R.^{Z^{2*Z2^{2*Z^{33}}}(S_v)^2})/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (105030792781.*R.^{36}*S2^{2*Z^{34}}(S_v)^2)/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (855.*R.^{36}.*R.^{Z^{2*Z2^{2*Z^{34}}}(S_v)^2})/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.^{Z^{2*Z2^{2*Z^{35}}}(S_v)^2})/(1729382256910270464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (548568674633.*R.^{38}*S2^{2*Z^{36}}(S_v)^2)/... \\
& (110680464442257309696*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1805.*R.^{38}.*R.^{Z^{2*Z2^{2*Z^{36}}}(S_v)^2})/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.^{Z^{2*Z2^{2*Z^{37}}}(S_v)^2})/(13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (10322387501.*R.^{40}*S2^{2*Z^{38}}(S_v)^2)/... \\
& (13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (25.*R.^{40}.*R.^{Z^{2*Z2^{2*Z^{38}}}(S_v)^2})/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.^{Z^{2*Z2^{2*Z^{39}}}(S_v)^2})/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1462601471251.*R.^{42}*S2^{2*Z^{40}}(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^{42}.*R.^{Z^{2*Z2^{2*Z^{40}}}(S_v)^2})/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.^{Z^{2*Z2^{2*Z^{41}}}(S_v)^2})/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^{44}*S2^{2*Z^{42}}(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3115.*R.^{45}.*R.^{Z^{2*Z2^{2*Z^{43}}}(S_v)^2})/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}*S2^{2*Z^{44}}(S_v)^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& + \dots \\
& (49.*R.^{47}.*R.^{Z^{2*Z2^{2*Z^{45}}}(S_v)^2})/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^{48}*S2^{2*Z^{46}}(S_v)^2)/... \\
& (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5273670271697.*R.^{50}*S2^{2*Z^{48}}(S_v)^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& Z^{4/64})^4) + \dots \\
& (37823055319.*R.^{52}*S2^{2*Z^{50}}(S_v)^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& \dots \\
& (31266829573.*R.^{54}*S2^{2*Z^{52}}(S_v)^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& + \dots \\
& (305764487.*R.^{56}*S2^{2*Z^{54}}(S_v)^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (155671821505.*R.^{58}*S2^{2*Z^{56}}(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots
\end{aligned}$$

$$\begin{aligned}
& (8605263625.*R.^60*S2^2*Z^58*(S_v)^2)/(356526731314189519170947776512*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (4487015167.*R.^62*S2^2*Z^60*(S_v)^2)/(3802951800684688204490109616128*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (64197131.*R.^64*S2^2*Z^62*(S_v)^2)/(1267650600228229401496703205376*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (7366421503.*R.^66*S2^2*Z^64*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (118374655.*R.^68*S2^2*Z^66*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (103217975.*R.^70*S2^2*Z^68*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (1169089.*R.^72*S2^2*Z^70*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (16453715.*R.^74*S2^2*Z^72*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (234365.*R.^76*S2^2*Z^74*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (77905.*R.^78*S2^2*Z^76*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (175.*R.^80*S2^2*Z^78*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (49.*R.^82*S2^2*Z^80*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z^2/4 + Z^4/64)^4);
\end{aligned}$$

```

Ns2=Nf2+Nc+Nr2;
Phi2=Nf2./[Nc+Nr2];
Be2=1./[1+Phi2];
Gf2=Nf2./Ns2;
Gr2=[Nr2]./Ns2;
Nh2=Nc+Nr2;

```

$$\begin{aligned}
S3=8; \\
Nf3=Br^*[(Z^2).*exp(-2.*R.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-R.*Z)]; \\
Nr3=(R.^2*S3^2)/4 + (25.*R.^2*S3^2*(S_v))/(384*(1 + Z^2/4 + Z^4/64)^2) + \\
(R.^2.*R.*Z^2*S3^2*(S_v))/(4*(1 + Z^2/4 + Z^4/64)^2) - \\
(43.*R.^4*S3^2*Z^2*(S_v))/(384*(1 + Z^2/4 + Z^4/64)^2) ... \\
+ (5.*R.^5.*R.*Z*S3^2*Z^3*(S_v))/(32*(1 + Z^2/4 + Z^4/64)^2) + \\
(407.*R.^6*S3^2*Z^4*(S_v))/(4096*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(7.*R.^7.*R.*Z*S3^2*Z^5*(S_v))/(768*(1 + Z^2/4 + Z^4/64)^2) + \\
(539.*R.^8*S3^2*Z^6*(S_v))/(4096*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(85225.*R.^10*S3^2*Z^8*(S_v))/(1572864*(1 + Z^2/4 + Z^4/64)^2) + \\
(6487.*R.^12*S3^2*Z^10*(S_v))/(393216*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(17773.*R.^14*S3^2*Z^12*(S_v))/(4194304*(1 + Z^2/4 + Z^4/64)^2) + \\
(2011.*R.^16*S3^2*Z^14*(S_v))/(2097152*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(206775.*R.^18*S3^2*Z^16*(S_v))/(1073741824*(1 + Z^2/4 + Z^4/64)^2) + \\
(108275.*R.^20*S3^2*Z^18*(S_v))/(3221225472*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(512435.*R.^22*S3^2*Z^20*(S_v))/(103079215104*(1 + Z^2/4 + Z^4/64)^2) + \\
(21031.*R.^24*S3^2*Z^22*(S_v))/(34359738368*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(272987.*R.^26*S3^2*Z^24*(S_v))/(4398046511104*(1 + Z^2/4 + Z^4/64)^2) + \\
(11305.*R.^28*S3^2*Z^26*(S_v))/(2199023255552*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(24225.*R.^30*S3^2*Z^28*(S_v))/(70368744177664*(1 + Z^2/4 + Z^4/64)^2) + \\
(323.*R.^32*S3^2*Z^30*(S_v))/(17592186044416*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(27455.*R.^34*S3^2*Z^32*(S_v))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + \\
(855.*R.^36*S3^2*Z^34*(S_v))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + \dots
\end{aligned}$$

$$\begin{aligned}
& (1805.*R.^{38}*S3^{2*}Z^{36}*(S_v))/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (25.*R.^{40}*S3^{2*}Z^{38}*(S_v))/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (7.*R.^{42}*S3^{2*}Z^{40}*(S_v))/(147573952589676412928*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (625.*R.^{42}*S3^{2*}(S_v)^2)/(147456*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (25.*R.^{42}.*R.*Z^{2*}S3^{2*}(S_v)^2)/(768*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (R.^{42}.*R.*Z^{4*}S3^{2*}(S_v)^2)/(16*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (1075.*R.^{44}*S3^{2*}Z^{2*}(S_v)^2)/(73728*(1 + Z^{2/4} + Z^{4/64})^4) - \\
& (43.*R.^{44}.*R.*Z^{2*}S3^{2*}Z^{2*}(S_v)^2)/(768*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (125.*R.^{45}.*R.*Z^{3*}S3^{2*}Z^{3*}(S_v)^2)/(6144*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5.*R.^{45}.*R.*Z^{3*}S3^{2*}Z^{3*}(S_v)^2)/(64*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (60109.*R.^{46}*S3^{2*}Z^{4*}(S_v)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (407.*R.^{46}.*R.*Z^{2*}S3^{2*}Z^{4*}(S_v)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (4985.*R.^{47}.*R.*Z^{3*}S3^{2*}Z^{5*}(S_v)^2)/(147456*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^{47}.*R.*Z^{3*}S3^{2*}Z^{5*}(S_v)^2)/(1536*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (671.*R.^{48}*S3^{2*}Z^{6*}(S_v)^2)/(131072*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (739.*R.^{48}.*R.*Z^{2*}S3^{2*}Z^{6*}(S_v)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (17111.*R.^{49}.*R.*Z^{2*}S3^{2*}Z^{7*}(S_v)^2)/(589824*(1 + Z^{2/4} + Z^{4/64})^4) - \\
& (3787661.*R.^{49}.*S3^{2*}Z^{8*}(S_v)^2)/(301989888*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (31395.*R.^{50}.*R.*Z^{2*}S3^{2*}Z^{8*}(S_v)^2)/(1048576*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (67529.*R.^{51}.*R.*Z^{2*}S3^{2*}Z^{9*}(S_v)^2)/(1572864*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1627151.*R.^{52}.*S3^{2*}Z^{10*}(S_v)^2)/(100663296*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (19657.*R.^{52}.*R.*Z^{2*}S3^{2*}Z^{10*}(S_v)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (486493.*R.^{53}.*R.*Z^{2*}S3^{2*}Z^{11*}(S_v)^2)/(25165824*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (241027273.*R.^{54}.*S3^{2*}Z^{12*}(S_v)^2)/(9663676416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (17773.*R.^{54}.*R.*Z^{2*}S3^{2*}Z^{12*}(S_v)^2)/(8388608*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3710335.*R.^{55}.*R.*Z^{2*}S3^{2*}Z^{13*}(S_v)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (53842355.*R.^{56}.*R.*Z^{2*}S3^{2*}Z^{14*}(S_v)^2)/(3221225472*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (2011.*R.^{56}.*R.*Z^{2*}S3^{2*}Z^{14*}(S_v)^2)/(4194304*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (981421.*R.^{57}.*R.*Z^{2*}S3^{2*}Z^{15*}(S_v)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (19618549477.*R.^{57}.*R.*Z^{2*}S3^{2*}Z^{16*}(S_v)^2)/(2473901162496*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (206775.*R.^{58}.*R.*Z^{2*}S3^{2*}Z^{16*}(S_v)^2)/(2147483648*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (607051.*R.^{59}.*R.*Z^{2*}S3^{2*}Z^{17*}(S_v)^2)/(1610612736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (944668661.*R.^{59}.*R.*Z^{20*}S3^{2*}Z^{18*}(S_v)^2)/(309237645312*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108275.*R.^{60}.*R.*Z^{2*}S3^{2*}Z^{18*}(S_v)^2)/(6442450944*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4002553.*R.^{61}.*R.*Z^{2*}S3^{2*}Z^{19*}(S_v)^2)/(51539607552*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3348433219.*R.^{62}.*R.*Z^{22*}S3^{2*}Z^{20*}(S_v)^2)/(3298534883328*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (512435.*R.^{62}.*R.*Z^{2*}S3^{2*}Z^{20*}(S_v)^2)/(206158430208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5778425.*R.^{63}.*R.*Z^{2*}S3^{2*}Z^{21*}(S_v)^2)/(412316860416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1484626111.*R.^{64}.*R.*Z^{24*}S3^{2*}Z^{22*}(S_v)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (21031.*R.^{64}.*R.*Z^{24*}S3^{2*}Z^{22*}(S_v)^2)/(68719476736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (10718225.*R.^{65}.*R.*Z^{25*}S3^{2*}Z^{23*}(S_v)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (33848465467.*R.^{66}.*R.*Z^{26*}S3^{2*}Z^{24*}(S_v)^2)/(422212465065984*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (272987.*R.^{66}.*R.*Z^{26*}S3^{2*}Z^{24*}(S_v)^2)/(8796093022208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11158205.*R.^{67}.*R.*Z^{27*}S3^{2*}Z^{25*}(S_v)^2)/(39582418599936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24750045961.*R.^{68}.*R.*Z^{28*}S3^{2*}Z^{26*}(S_v)^2)/(1266637395197952*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11305.*R.^{69}.*R.*Z^{28*}S3^{2*}Z^{26*}(S_v)^2)/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (6450277.*R.^{70}.*R.*Z^{29*}S3^{2*}Z^{27*}(S_v)^2)/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (59064594011.*R.^{70}.*R.*Z^{30*}S3^{2*}Z^{28*}(S_v)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24225.*R.^{71}.*R.*Z^{2*}S3^{2*}Z^{28*}(S_v)^2)/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (4624109.*R.^{71}.*R.*Z^{31*}S3^{2*}Z^{29*}(S_v)^2)/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (36553306561.*R.^{72}.*R.*Z^{32*}S3^{2*}Z^{30*}(S_v)^2)/(40532396464334464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (323.*R.^{72}.*R.*Z^{32*}S3^{2*}Z^{30*}(S_v)^2)/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (679915.*R.^{73}.*R.*Z^{33*}S3^{2*}Z^{31*}(S_v)^2)/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1189947216611.*R.^{73}.*R.*Z^{34*}S3^{2*}Z^{32*}(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (27455.*R.^{74}.*R.*Z^{34*}S3^{2*}Z^{32*}(S_v)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108205.*R.^{75}.*R.*Z^{35*}S3^{2*}Z^{33*}(S_v)^2)/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) + \dots
\end{aligned}$$

$$\begin{aligned}
& (105030792781.*R.^{36}*S3^{^2}*Z^{^34}*(S_v)^{^2})/(3458764513820540928*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (855.*R.^{36}.*R.*Z^{^2}*S3^{^2}*Z^{^34}*(S_v)^{^2})/(72057594037927936*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (990641.*R.^{37}.*R.*Z^{^2}S3^{^2}Z^{^35}*(S_v)^{^2})/(1729382256910270464*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (548568674633.*R.^{38}S3^{^2}Z^{^36}*(S_v)^{^2})/... \\
& (110680464442257309696*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (1805.*R.^{38}.*R.*Z^{^2}S3^{^2}Z^{^36}*(S_v)^{^2})/(6917529027641081856*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (294785.*R.^{39}.*R.*Z^{^2}S3^{^2}Z^{^37}*(S_v)^{^2})/(13835058055282163712*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (10322387501.*R.^{40}S3^{^2}Z^{^38}*(S_v)^{^2})/... \\
& (1383505805282163712*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (25.*R.^{40}.*R.*Z^{^2}S3^{^2}Z^{^38}*(S_v)^{^2})/(6917529027641081856*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (32965.*R.^{41}.*R.*Z^{^2}S3^{^2}Z^{^39}*(S_v)^{^2})/(55340232221128654848*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (1462601471251.*R.^{42}S3^{^2}Z^{^40}*(S_v)^{^2})/... \\
& (14167099448608935641088*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (7.*R.^{42}.*R.*Z^{^2}S3^{^2}Z^{^40}*(S_v)^{^2})/(295147905179352825856*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (15635.*R.^{43}.*R.*Z^{^2}S3^{^2}Z^{^41}*(S_v)^{^2})/(1328165573307087716352*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (185335180013.*R.^{44}S3^{^2}Z^{^42}*(S_v)^{^2})/... \\
& (14167099448608935641088*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (3115.*R.^{45}.*R.*Z^{^2}S3^{^2}Z^{^43}*(S_v)^{^2})/(21250649172913403461632*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (2057042720599.*R.^{46}S3^{^2}Z^{^44}*(S_v)^{^2})/(1360041547066457821544448*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (49.*R.^{47}.*R.*Z^{^2}S3^{^2}Z^{^45}*(S_v)^{^2})/(56668397794435742564352*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (24026340573.*R.^{48}S3^{^2}Z^{^46}*(S_v)^{^2})/... \\
& (151115727451828646838272*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \\
& (5273670271697.*R.^{50}S3^{^2}Z^{^48}*(S_v)^{^2})/(348170636049013202315378688*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (37823055319.*R.^{52}S3^{^2}Z^{^50}*(S_v)^{^2})/(29014219670751100192948224*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (31266829573.*R.^{54}S3^{^2}Z^{^52}*(S_v)^{^2})/(309485009821345068724781056*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (305764487.*R.^{56}S3^{^2}Z^{^54}*(S_v)^{^2})/(43521329506126650289422336*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (155671821505.*R.^{58}S3^{^2}Z^{^56}*(S_v)^{^2})/(356526731314189519170947776512*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (8605263625.*R.^{60}S3^{^2}Z^{^58}*(S_v)^{^2})/(356526731314189519170947776512*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (4487015167.*R.^{62}S3^{^2}Z^{^60}*(S_v)^{^2})/(3802951800684688204490109616128*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (64197131.*R.^{64}S3^{^2}Z^{^62}*(S_v)^{^2})/(1267650600228229401496703205376*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (7366421503.*R.^{66}S3^{^2}Z^{^64}*(S_v)^{^2})/(3894222643901120721397872246915072*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (118374655.*R.^{68}S3^{^2}Z^{^66}*(S_v)^{^2})/(1947111321950560360698936123457536*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (103217975.*R.^{70}S3^{^2}Z^{^68}*(S_v)^{^2})/(62307562302417931542365955950641152*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (1169089.*R.^{72}S3^{^2}Z^{^70}*(S_v)^{^2})/(31153781151208965771182977975320576*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (16453715.*R.^{74}S3^{^2}Z^{^72}*(S_v)^{^2})/(23926103924128485712268527085046202368*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (234365.*R.^{76}S3^{^2}Z^{^74}*(S_v)^{^2})/(23926103924128485712268527085046202368*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (77905.*R.^{78}S3^{^2}Z^{^76}*(S_v)^{^2})/(765635325572111542792592866721478475776*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (175.*R.^{80}S3^{^2}Z^{^78}*(S_v)^{^2})/(255211775190703847597530955573826158592*(1 + Z^{^2/4} + Z^{^4/64})^{^4}) + \dots \\
& (49.*R.^{82}S3^{^2}Z^{^80}*(S_v)^{^2})/(21778071482940061661655974875633165533184*(1 + Z^{^2/4} + Z^{^4/64})^{^4}); 
\end{aligned}$$

```

Ns3=Nf3+Nc+Nr3;
Phi3=Nf3./[Nc+Nr3];
Be3=1./[1+Phi3];
Gf3=Nf3./Ns3;
Gr3=[Nr3]./Ns3;
Nh3=Nc+Nr3;

```

```

S4=12;
Nf4=Br*[(Z^2).*exp(-2.*R.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-R.*Z)];
Nr4=(R.^2*S4^2)/4 + (25.*R.^2*S4^2*(S_v))/(384*(1 + Z^2/4 + Z^4/64)^2)+ (R.^2.*R.*Z^2*S4^2*(S_v))/(4*(1 + Z^2/4 + Z^4/64)^2) - ...
(43.*R.^4*S4^2*Z^2*(S_v))/(384*(1 + Z^2/4 + Z^4/64)^2)...
+ (5.*R.^5.*R.*Z*S4^2*Z^3*(S_v))/(32*(1 + Z^2/4 + Z^4/64)^2)+ ...
(407.*R.^6*S4^2*Z^4*(S_v))/(4096*(1 + Z^2/4 + Z^4/64)^2) + ...
(7.*R.^7.*R.*Z*S4^2*Z^5*(S_v))/(768*(1 + Z^2/4 + Z^4/64)^2) + ...
(539.*R.^8*S4^2*Z^6*(S_v))/(4096*(1 + Z^2/4 + Z^4/64)^2) + ...
(85225.*R.^10*S4^2*Z^8*(S_v))/(1572864*(1 + Z^2/4 + Z^4/64)^2) + ...
(6487.*R.^12*S4^2*Z^10*(S_v))/(393216*(1 + Z^2/4 + Z^4/64)^2) + ...
(17773.*R.^14*S4^2*Z^12*(S_v))/(4194304*(1 + Z^2/4 + Z^4/64)^2) + ...
(2011.*R.^16*S4^2*Z^14*(S_v))/(2097152*(1 + Z^2/4 + Z^4/64)^2) + ...
(206775.*R.^18*S4^2*Z^16*(S_v))/(1073741824*(1 + Z^2/4 + Z^4/64)^2) + ...
(108275.*R.^20*S4^2*Z^18*(S_v))/(3221225472*(1 + Z^2/4 + Z^4/64)^2) + ...
(512435.*R.^22*S4^2*Z^20*(S_v))/(103079215104*(1 + Z^2/4 + Z^4/64)^2) + ...
(21031.*R.^24*S4^2*Z^22*(S_v))/(34359738368*(1 + Z^2/4 + Z^4/64)^2) + ...
(272987.*R.^26*S4^2*Z^24*(S_v))/(4398046511104*(1 + Z^2/4 + Z^4/64)^2) + ...
(11305.*R.^28*S4^2*Z^26*(S_v))/(2199023255552*(1 + Z^2/4 + Z^4/64)^2) + ...
(24225.*R.^30*S4^2*Z^28*(S_v))/(70368744177664*(1 + Z^2/4 + Z^4/64)^2) + ...
(323.*R.^32*S4^2*Z^30*(S_v))/(17592186044416*(1 + Z^2/4 + Z^4/64)^2) + ...
(27455.*R.^34*S4^2*Z^32*(S_v))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + ...
(855.*R.^36*S4^2*Z^34*(S_v))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + ...
(1805.*R.^38*S4^2*Z^36*(S_v))/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^2) + ...
(25.*R.^40*S4^2*Z^38*(S_v))/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^2) + ...
(7.*R.^42*S4^2*Z^40*(S_v))/(147573952589676412928*(1 + Z^2/4 + Z^4/64)^2) + ...
(625.*R.^2*S4^2*(S_v)^2)/(147456*(1 + Z^2/4 + Z^4/64)^4) + ...
(25.*R.^2.*R.*Z^2*S4^2*(S_v)^2)/(768*(1 + Z^2/4 + Z^4/64)^4) + ...
(R.^2.*R.*Z^4*S4^2*(S_v)^2)/(16*(1 + Z^2/4 + Z^4/64)^4) - ...
(1075.*R.^4*S4^2*Z^2*(S_v)^2)/(73728*(1 + Z^2/4 + Z^4/64)^4) - ...
(43.*R.^4.*R.*Z^2*S4^2*Z^2*(S_v)^2)/(768*(1 + Z^2/4 + Z^4/64)^4) + ...
(125.*R.^5.*R.*Z*S4^2*Z^3*(S_v)^2)/(6144*(1 + Z^2/4 + Z^4/64)^4) + ...
(5.*R.^5.*R.*Z^3*S4^2*Z^3*(S_v)^2)/(64*(1 + Z^2/4 + Z^4/64)^4) + ...
(60109.*R.^6*S4^2*Z^4*(S_v)^2)/(2359296*(1 + Z^2/4 + Z^4/64)^4) + ...
(407.*R.^6.*R.*Z^2*S4^2*Z^4*(S_v)^2)/(8192*(1 + Z^2/4 + Z^4/64)^4) - ...
(4985.*R.^7.*R.*Z*S4^2*Z^5*(S_v)^2)/(147456*(1 + Z^2/4 + Z^4/64)^4) + ...
(7.*R.^7.*R.*Z^3*S4^2*Z^5*(S_v)^2)/(1536*(1 + Z^2/4 + Z^4/64)^4) - ...
(671.*R.^8*S4^2*Z^6*(S_v)^2)/(131072*(1 + Z^2/4 + Z^4/64)^4) + ...
(739.*R.^8.*R.*Z^2*S4^2*Z^6*(S_v)^2)/(8192*(1 + Z^2/4 + Z^4/64)^4) + ...
(17111.*R.^9.*R.*Z*S4^2*Z^7*(S_v)^2)/(589824*(1 + Z^2/4 + Z^4/64)^4) - ...
(3787661.*R.^10*S4^2*Z^8*(S_v)^2)/(301989888*(1 + Z^2/4 + Z^4/64)^4) + ...
(31395.*R.^10.*R.*Z^2*S4^2*Z^8*(S_v)^2)/(1048576*(1 + Z^2/4 + Z^4/64)^4) + ...
(67529.*R.^11.*R.*Z*S4^2*Z^9*(S_v)^2)/(1572864*(1 + Z^2/4 + Z^4/64)^4) + ...
(1627151.*R.^12*S4^2*Z^10*(S_v)^2)/(100663296*(1 + Z^2/4 + Z^4/64)^4) + ...
(19657.*R.^12.*R.*Z^2*S4^2*Z^10*(S_v)^2)/(2359296*(1 + Z^2/4 + Z^4/64)^4) + ...
(486493.*R.^13.*R.*Z*S4^2*Z^11*(S_v)^2)/(25165824*(1 + Z^2/4 + Z^4/64)^4) + ...
(241027273.*R.^14*S4^2*Z^12*(S_v)^2)/(9663676416*(1 + Z^2/4 + Z^4/64)^4) + ...

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$$\begin{aligned}
& (17773.*R.^{14}.*R.*Z^2*S4^2*Z^12*(S_v)^2)/(8388608*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3710335.*R.^{15}.*R.*Z*S4^2*Z^13*(S_v)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (53842355.*R.^{16}.*S4^2*Z^14*(S_v)^2)/(3221225472*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (2011.*R.^{16}.*R.*Z^2*S4^2*Z^14*(S_v)^2)/(4194304*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (981421.*R.^{17}.*R.*Z*S4^2*Z^15*(S_v)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (19618549477.*R.^{18}.*S4^2*Z^16*(S_v)^2)/(2473901162496*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (206775.*R.^{18}.*R.*Z^2*S4^2*Z^16*(S_v)^2)/(2147483648*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (607051.*R.^{19}.*R.*Z*S4^2*Z^17*(S_v)^2)/(1610612736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (944668661.*R.^{20}.*S4^2*Z^18*(S_v)^2)/(309237645312*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108275.*R.^{20}.*R.*Z^2*S4^2*Z^18*(S_v)^2)/(6442450944*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4002553.*R.^{21}.*R.*Z*S4^2*Z^19*(S_v)^2)/(51539607552*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3348433219.*R.^{22}.*S4^2*Z^20*(S_v)^2)/(3298534883328*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (512435.*R.^{22}.*R.*Z^2*S4^2*Z^20*(S_v)^2)/(206158430208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5778425.*R.^{23}.*R.*Z*S4^2*Z^21*(S_v)^2)/(412316860416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1484626111.*R.^{24}.*S4^2*Z^22*(S_v)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (21031.*R.^{24}.*R.*Z^2*S4^2*Z^22*(S_v)^2)/(68719476736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (10718225.*R.^{25}.*R.*Z*S4^2*Z^23*(S_v)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (33848465467.*R.^{26}.*S4^2*Z^24*(S_v)^2)/(422212465065984*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (272987.*R.^{26}.*R.*Z^2*S4^2*Z^24*(S_v)^2)/(8796093022208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11158205.*R.^{27}.*R.*Z^2*S4^2*Z^25*(S_v)^2)/(39582418599936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24750045961.*R.^{28}.*S4^2*Z^26*(S_v)^2)/(1266637395197952*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11305.*R.^{28}.*R.*Z^2*S4^2*Z^26*(S_v)^2)/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (6450277.*R.^{29}.*R.*Z*S4^2*Z^27*(S_v)^2)/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (59064594011.*R.^{30}.*S4^2*Z^28*(S_v)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24225.*R.^{30}.*R.*Z^2*S4^2*Z^28*(S_v)^2)/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (4624109.*R.^{31}.*R.*Z*S4^2*Z^29*(S_v)^2)/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (36553306561.*R.^{32}.*S4^2*Z^30*(S_v)^2)/(40532396646334464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (323.*R.^{32}.*R.*Z^2*S4^2*Z^30*(S_v)^2)/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (679915.*R.^{33}.*R.*Z*S4^2*Z^31*(S_v)^2)/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1189947216611.*R.^{34}.*S4^2*Z^32*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (27455.*R.^{34}.*R.*Z^2*S4^2*Z^32*(S_v)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108205.*R.^{35}.*R.*Z^2*S4^2*Z^33*(S_v)^2)/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (105030792781.*R.^{36}.*S4^2*Z^34*(S_v)^2)/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (855.*R.^{36}.*R.*Z^2*S4^2*Z^34*(S_v)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.*Z^2*S4^2*Z^35*(S_v)^2)/(1729382256910270464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (548568674633.*R.^{38}.*S4^2*Z^36*(S_v)^2)/... \\
& (110680464442257309696*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1805.*R.^{38}.*R.*Z^2*S4^2*Z^36*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.*Z^2*S4^2*Z^37*(S_v)^2)/(13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (10322387501.*R.^{40}.*S4^2*Z^38*(S_v)^2)/... \\
& (13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (25.*R.^{40}.*R.*Z^2*S4^2*Z^38*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.*Z^2*S4^2*Z^39*(S_v)^2)/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1462601471251.*R.^{42}.*S4^2*Z^40*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^{42}.*R.*Z^2*S4^2*Z^40*(S_v)^2)/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.*Z^2*S4^2*Z^41*(S_v)^2)/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^{44}.*S4^2*Z^42*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3115.*R.^{45}.*R.*Z^2*S4^2*Z^43*(S_v)^2)/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}.*S4^2*Z^44*(S_v)^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& + \dots \\
& (49.*R.^{47}.*R.*Z^2*S4^2*Z^45*(S_v)^2)/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^{48}.*S4^2*Z^46*(S_v)^2)/...
\end{aligned}$$

$$\begin{aligned}
& (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5273670271697.*R.^50*S4^2*Z^48*(S_v)^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (37823055319.*R.^52*S4^2*Z^50*(S_v)^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (31266829573.*R.^54*S4^2*Z^52*(S_v)^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (305764487.*R.^56*S4^2*Z^54*(S_v)^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (155671821505.*R.^58*S4^2*Z^56*(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (8605263625.*R.^60*S4^2*Z^58*(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4487015167.*R.^62*S4^2*Z^60*(S_v)^2)/(3802951800684688204490109616128*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (64197131.*R.^64*S4^2*Z^62*(S_v)^2)/(1267650600228229401496703205376*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (7366421503.*R.^66*S4^2*Z^64*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (118374655.*R.^68*S4^2*Z^66*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (103217975.*R.^70*S4^2*Z^68*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1169089.*R.^72*S4^2*Z^70*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (16453715.*R.^74*S4^2*Z^72*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (234365.*R.^76*S4^2*Z^74*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (77905.*R.^78*S4^2*Z^76*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (175.*R.^80*S4^2*Z^78*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (49.*R.^82*S4^2*Z^80*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z^{2/4} + Z^{4/64})^4);
\end{aligned}$$

Ns4=Nf4+Nc+Nr4;  
 Phi4=Nf4./[Nc+Nr4];  
 Be4=1./[1+Phi4];  
 Gf4=Nf4./Ns4;  
 Gr4=[Nr4]./Ns4;  
 Nh4=Nc+Nr4;

S5=16;  
 Nf5=Br\*[(Z^2).\*exp(-2.\*R.\*Z)+(Z^2)\*exp(-2\*Z)-2\*Z^2.\*exp(-Z-R.\*Z)];  
 Nr5=(R.^2\*S5^2)/4 + (25.\*R.^2\*S5^2\*(S\_v))/(384\*(1 + Z^{2/4} + Z^{4/64})^2)+  
 (R.^2.\*R.^2\*S5^2\*(S\_v))/(4\*(1 + Z^{2/4} + Z^{4/64})^2) - ...  
 (43.\*R.^4\*S5^2\*Z^2\*(S\_v))/(384\*(1 + Z^{2/4} + Z^{4/64})^2)...  
 + (5.\*R.^5.\*R.^2\*Z\*S5^2\*Z^3\*(S\_v))/(32\*(1 + Z^{2/4} + Z^{4/64})^2)+  
 (407.\*R.^6\*S5^2\*Z^4\*(S\_v))/(4096\*(1 + Z^{2/4} + Z^{4/64})^2) + ...  
 (7.\*R.^7.\*R.^2\*Z\*S5^2\*Z^5\*(S\_v))/(768\*(1 + Z^{2/4} + Z^{4/64})^2) + ...  
 (539.\*R.^8\*S5^2\*Z^6\*(S\_v))/(4096\*(1 + Z^{2/4} + Z^{4/64})^2) + ...  
 (85225.\*R.^10\*S5^2\*Z^8\*(S\_v))/(1572864\*(1 + Z^{2/4} + Z^{4/64})^2) + ...  
 (6487.\*R.^12\*S5^2\*Z^10\*(S\_v))/(393216\*(1 + Z^{2/4} + Z^{4/64})^2) + ...  
 (17773.\*R.^14\*S5^2\*Z^12\*(S\_v))/(4194304\*(1 + Z^{2/4} + Z^{4/64})^2) + ...  
 (2011.\*R.^16\*S5^2\*Z^14\*(S\_v))/(2097152\*(1 + Z^{2/4} + Z^{4/64})^2) + ...

$$\begin{aligned}
& (206775.*R.^{18}*S5^{^2}*Z^{16}*(S_v))/(1073741824*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \\
& (108275.*R.^{20}*S5^{^2}*Z^{18}*(S_v))/(3221225472*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \dots \\
& (512435.*R.^{22}*S5^{^2}*Z^{20}*(S_v))/(103079215104*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \\
& (21031.*R.^{24}*S5^{^2}*Z^{22}*(S_v))/(34359738368*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \dots \\
& (272987.*R.^{26}*S5^{^2}*Z^{24}*(S_v))/(4398046511104*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \\
& (11305.*R.^{28}*S5^{^2}*Z^{26}*(S_v))/(2199023255552*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \dots \\
& (24225.*R.^{30}*S5^{^2}*Z^{28}*(S_v))/(70368744177664*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \\
& (323.*R.^{32}*S5^{^2}*Z^{30}*(S_v))/(17592186044416*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \dots \\
& (27455.*R.^{34}*S5^{^2}*Z^{32}*(S_v))/(36028797018963968*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \\
& (855.*R.^{36}*S5^{^2}*Z^{34}*(S_v))/(36028797018963968*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \dots \\
& (1805.*R.^{38}*S5^{^2}*Z^{36}*(S_v))/(3458764513820540928*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \\
& (25.*R.^{40}*S5^{^2}*Z^{38}*(S_v))/(3458764513820540928*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \dots \\
& (7.*R.^{42}*S5^{^2}*Z^{40}*(S_v))/(147573952589676412928*(1 + Z^{^2/4} + Z^{4/64})^{^2}) + \\
& (625.*R.^{2}*S5^{^2}*(S_v)^{^2})/(147456*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (25.*R.^{2}.*R.^{2}*S5^{^2}*(S_v)^{^2})/(768*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (R.^{2}.*R.^{2}*Z^{4}*S5^{^2}*(S_v)^{^2})/(16*(1 + Z^{^2/4} + Z^{4/64})^{^4}) - \dots \\
& (1075.*R.^{4}*S5^{^2}*Z^{2}*(S_v)^{^2})/(73728*(1 + Z^{^2/4} + Z^{4/64})^{^4}) - \\
& (43.*R.^{4}.*R.^{2}*Z^{2}*S5^{^2}*Z^{2}*(S_v)^{^2})/(768*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (125.*R.^{5}.*R.^{2}*Z^{3}*S5^{^2}*Z^{3}*(S_v)^{^2})/(6144*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (5.*R.^{5}.*R.^{2}*Z^{3}*S5^{^2}*Z^{3}*(S_v)^{^2})/(64*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (60109.*R.^{6}*S5^{^2}*Z^{4}*(S_v)^{^2})/(2359296*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (407.*R.^{6}.*R.^{2}*S5^{^2}*Z^{4}*(S_v)^{^2})/(8192*(1 + Z^{^2/4} + Z^{4/64})^{^4}) - \dots \\
& (4985.*R.^{7}.*R.^{2}*S5^{^2}*Z^{5}*(S_v)^{^2})/(147456*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (7.*R.^{7}.*R.^{2}*Z^{3}*S5^{^2}*Z^{5}*(S_v)^{^2})/(1536*(1 + Z^{^2/4} + Z^{4/64})^{^4}) - \dots \\
& (671.*R.^{8}*S5^{^2}*Z^{6}*(S_v)^{^2})/(131072*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (739.*R.^{8}.*R.^{2}*S5^{^2}*Z^{6}*(S_v)^{^2})/(8192*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (17111.*R.^{9}.*R.^{2}*S5^{^2}*Z^{7}*(S_v)^{^2})/(589824*(1 + Z^{^2/4} + Z^{4/64})^{^4}) - \\
& (3787661.*R.^{10}*S5^{^2}*Z^{8}*(S_v)^{^2})/(301989888*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (31395.*R.^{10}.*R.^{2}*S5^{^2}*Z^{8}*(S_v)^{^2})/(1048576*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (67529.*R.^{11}.*R.^{2}*S5^{^2}*Z^{9}*(S_v)^{^2})/(1572864*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (1627151.*R.^{12}*S5^{^2}*Z^{10}*(S_v)^{^2})/(100663296*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (19657.*R.^{12}.*R.^{2}*S5^{^2}*Z^{10}*(S_v)^{^2})/(2359296*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (486493.*R.^{13}.*R.^{2}*S5^{^2}*Z^{11}*(S_v)^{^2})/(25165824*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (241027273.*R.^{14}*S5^{^2}*Z^{12}*(S_v)^{^2})/(9663676416*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (17773.*R.^{14}.*R.^{2}*S5^{^2}*Z^{12}*(S_v)^{^2})/(8388608*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (3710335.*R.^{15}.*R.^{2}*S5^{^2}*Z^{13}*(S_v)^{^2})/(603979776*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (53842355.*R.^{16}*S5^{^2}*Z^{14}*(S_v)^{^2})/(3221225472*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (2011.*R.^{16}.*R.^{2}*S5^{^2}*Z^{14}*(S_v)^{^2})/(4194304*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (981421.*R.^{17}.*R.^{2}*S5^{^2}*Z^{15}*(S_v)^{^2})/(603979776*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (19618549477.*R.^{18}*S5^{^2}*Z^{16}*(S_v)^{^2})/(2473901162496*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (206775.*R.^{18}.*R.^{2}*S5^{^2}*Z^{16}*(S_v)^{^2})/(2147483648*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (607051.*R.^{19}.*R.^{2}*S5^{^2}*Z^{17}*(S_v)^{^2})/(1610612736*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (944668661.*R.^{20}*S5^{^2}*Z^{18}*(S_v)^{^2})/(309237645312*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (108275.*R.^{20}.*R.^{2}*S5^{^2}*Z^{18}*(S_v)^{^2})/(6442450944*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (4002553.*R.^{21}.*R.^{2}*S5^{^2}*Z^{19}*(S_v)^{^2})/(51539607552*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (3348433219.*R.^{22}*S5^{^2}*Z^{20}*(S_v)^{^2})/(3298534883328*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (512435.*R.^{22}.*R.^{2}*S5^{^2}*Z^{20}*(S_v)^{^2})/(206158430208*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (5778425.*R.^{23}.*R.^{2}*S5^{^2}*Z^{21}*(S_v)^{^2})/(412316860416*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (1484626111.*R.^{24}*S5^{^2}*Z^{22}*(S_v)^{^2})/(4947802324992*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (21031.*R.^{24}.*R.^{2}*S5^{^2}*Z^{22}*(S_v)^{^2})/(68719476736*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (10718225.*R.^{25}.*R.^{2}*S5^{^2}*Z^{23}*(S_v)^{^2})/(4947802324992*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (33848465467.*R.^{26}*S5^{^2}*Z^{24}*(S_v)^{^2})/(422212465065984*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (272987.*R.^{26}.*R.^{2}*S5^{^2}*Z^{24}*(S_v)^{^2})/(8796093022208*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (11158205.*R.^{27}.*R.^{2}*S5^{^2}*Z^{25}*(S_v)^{^2})/(39582418599936*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots \\
& (24750045961.*R.^{28}*S5^{^2}*Z^{26}*(S_v)^{^2})/(1266637395197952*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \\
& (11305.*R.^{28}.*R.^{2}*S5^{^2}*Z^{26}*(S_v)^{^2})/(4398046511104*(1 + Z^{^2/4} + Z^{4/64})^{^4}) + \dots
\end{aligned}$$

$$\begin{aligned}
& (6450277.*R.^{29}.*R.*Z*S5^2*Z^{27}*(S_v)^2)/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (59064594011.*R.^{30}*S5^2*Z^{28}*(S_v)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24225.*R.^{30}.*R.*Z^2*S5^2*Z^{28}*(S_v)^2)/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (4624109.*R.^{31}.*R.*Z*S5^2*Z^{29}*(S_v)^2)/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (36553306561.*R.^{32}*S5^2*Z^{30}*(S_v)^2)/(40532396646334464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (323.*R.^{32}.*R.*Z^2*S5^2*Z^{30}*(S_v)^2)/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (679915.*R.^{33}.*R.*Z*S5^2*Z^{31}*(S_v)^2)/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1189947216611.*R.^{34}*S5^2*Z^{32}*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (27455.*R.^{34}.*R.*Z^2*S5^2*Z^{32}*(S_v)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108205.*R.^{35}.*R.*Z*S5^2*Z^{33}*(S_v)^2)/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (105030792781.*R.^{36}*S5^2*Z^{34}*(S_v)^2)/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (855.*R.^{36}.*R.*Z^2*S5^2*Z^{34}*(S_v)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.*Z*S5^2*Z^{35}*(S_v)^2)/(1729382256910270464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (548568674633.*R.^{38}*S5^2*Z^{36}*(S_v)^2)/... \\
& (110680464442257309696*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1805.*R.^{38}.*R.*Z^2*S5^2*Z^{36}*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.*Z*S5^2*Z^{37}*(S_v)^2)/(13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (10322387501.*R.^{40}*S5^2*Z^{38}*(S_v)^2)/... \\
& (13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (25.*R.^{40}.*R.*Z^2*S5^2*Z^{38}*(S_v)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.*Z*S5^2*Z^{39}*(S_v)^2)/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1462601471251.*R.^{42}*S5^2*Z^{40}*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^{42}.*R.*Z^2*S5^2*Z^{40}*(S_v)^2)/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.*Z*S5^2*Z^{41}*(S_v)^2)/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^{44}*S5^2*Z^{42}*(S_v)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3115.*R.^{45}.*R.*Z*S5^2*Z^{43}*(S_v)^2)/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}*S5^2*Z^{44}*(S_v)^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (49.*R.^{47}.*R.*Z*S5^2*Z^{45}*(S_v)^2)/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^{48}*S5^2*Z^{46}*(S_v)^2)/... \\
& (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5273670271697.*R.^{50}*S5^2*Z^{48}*(S_v)^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (37823055319.*R.^{52}*S5^2*Z^{50}*(S_v)^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (31266829573.*R.^{54}*S5^2*Z^{52}*(S_v)^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (305764487.*R.^{56}*S5^2*Z^{54}*(S_v)^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (155671821505.*R.^{58}*S5^2*Z^{56}*(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (8605263625.*R.^{60}*S5^2*Z^{58}*(S_v)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4487015167.*R.^{62}*S5^2*Z^{60}*(S_v)^2)/(3802951800684688204490109616128*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (64197131.*R.^{64}*S5^2*Z^{62}*(S_v)^2)/(1267650600228229401496703205376*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (7366421503.*R.^{66}*S5^2*Z^{64}*(S_v)^2)/(3894222643901120721397872246915072*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (118374655.*R.^{68}*S5^2*Z^{66}*(S_v)^2)/(1947111321950560360698936123457536*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (103217975.*R.^{70}*S5^2*Z^{68}*(S_v)^2)/(62307562302417931542365955950641152*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1169089.*R.^{72}*S5^2*Z^{70}*(S_v)^2)/(31153781151208965771182977975320576*(1 + Z^{2/4} + Z^{4/64})^4) + \dots
\end{aligned}$$

```

(16453715.*R.^74*S5^2*Z^72*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^2/4 +
Z^4/64)^4) + ...
(234365.*R.^76*S5^2*Z^74*(S_v)^2)/(23926103924128485712268527085046202368*(1 + Z^2/4 +
Z^4/64)^4) + ...
(77905.*R.^78*S5^2*Z^76*(S_v)^2)/(765635325572111542792592866721478475776*(1 + Z^2/4 +
Z^4/64)^4) + ...
(175.*R.^80*S5^2*Z^78*(S_v)^2)/(255211775190703847597530955573826158592*(1 + Z^2/4 +
Z^4/64)^4) + ...
(49.*R.^82*S5^2*Z^80*(S_v)^2)/(21778071482940061661655974875633165533184*(1 + Z^2/4 +
Z^4/64)^4);

```

```

Ns5=Nf5+Nc+Nr5;
Phi5=Nf5./[Nc+Nr5];
Be5=1./[1+Phi5];
Gf5=Nf5./Ns5;
Gr5=[Nr5]./Ns5;
Nh5=Nc+Nr5;

```

```

plot(R,Ns1,'b',R,Ns2,'g',R,Ns3,'r',R,Ns4,'k',R,Ns5,'m')
% plot(R,Be1,'b',R,Be2,'g',R,Be3,'r',R,Be4,'k',R,Be5,'m')
% plot(R,Phi1,'b',R,Phi2,'g',R,Phi3,'r',R,Phi4,'k',R,Phi5,'m')
% plot(R,Gf1,'b',R,Gf2,'g',R,Gf3,'r',R,Gf4,'k',R,Gf5,'m')
% plot(R,Gr1,'b',R,Gr2,'g',R,Gr3,'r',R,Gr4,'k',R,Gr5,'m')
% plot(R,Nf1,'b',R,Nf2,'g',R,Nf3,'r',R,Nf4,'k',R,Nf5,'m')
% plot(R,Nh1,'b',R,Nh2,'g',R,Nh3,'r',R,Nh4,'k',R,Nh5,'m')

```

PLOTTOOLS ON

**2.5. Distribution of  $N_s$ ,  $Be$ ,  $\Phi$ ,  $G_F$ ,  $G_R$ ,  $N_F$  and  $N_H$  versus  $Y$  for a range of  $S_v$  and set of  $S$ ,  $Z$ ,  $Br$  &  $Pe$**

```

S=1; Z=1; Br=1; Pe=10;
% S=2.5; Z=2; Br=0.5; Pe=5;

% % % % Z=4; S=10; Br=0.6; Pe=8;
% % % % Z=5; S=0.75; Br=0.2; Pe=2;
% % % % Z=10; S=5; Br=1; Pe=7.5;
% % % % Z=20; S=15; Br=0.9; Pe=10;

q=1.86;
s=1;
Dh=250*10^-6;
R=0:0.005:1;

Nc=[1/Pe^2]*[16*q^2+s^2*Dh^2+8*q*s*Dh];

S_v1=1;
Nf1=Br*[(Z^2).*exp(-2.*R.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-R.*Z)];
Nr1=(R.^2*S^2)/4 + (25.*R.^2*S^2*(S_v1))/(384*(1 + Z^2/4 + Z^4/64)^2)+ (R.^2.*R.*Z^2*S^2*(S_v1))/(4*(1 + Z^2/4 + Z^4/64)^2) -...
(43.*R.^4*S^2*Z^2*(S_v1))/(384*(1 + Z^2/4 + Z^4/64)^2)...
+ (5.*R.^5.*R.*Z*S^2*Z^3*(S_v1))/(32*(1 + Z^2/4 + Z^4/64)^2)+ (407.*R.^6*S^2*Z^4*(S_v1))/(4096*(1 + Z^2/4 + Z^4/64)^2) + ...
(7.*R.^7.*R.*Z*S^2*Z^5*(S_v1))/(768*(1 + Z^2/4 + Z^4/64)^2) + ...
(539.*R.^8*S^2*Z^6*(S_v1))/(4096*(1 + Z^2/4 + Z^4/64)^2) + ...
(85225.*R.^10*S^2*Z^8*(S_v1))/(1572864*(1 + Z^2/4 + Z^4/64)^2) + ...
(6487.*R.^12*S^2*Z^10*(S_v1))/(393216*(1 + Z^2/4 + Z^4/64)^2) + ...
(17773.*R.^14*S^2*Z^12*(S_v1))/(4194304*(1 + Z^2/4 + Z^4/64)^2) + ...
(2011.*R.^16*S^2*Z^14*(S_v1))/(2097152*(1 + Z^2/4 + Z^4/64)^2) + ...
(206775.*R.^18*S^2*Z^16*(S_v1))/(1073741824*(1 + Z^2/4 + Z^4/64)^2) + ...
(108275.*R.^20*S^2*Z^18*(S_v1))/(3221225472*(1 + Z^2/4 + Z^4/64)^2) +...
(512435.*R.^22*S^2*Z^20*(S_v1))/(103079215104*(1 + Z^2/4 + Z^4/64)^2) + ...
(21031.*R.^24*S^2*Z^22*(S_v1))/(34359738368*(1 + Z^2/4 + Z^4/64)^2) +...
(272987.*R.^26*S^2*Z^24*(S_v1))/(4398046511104*(1 + Z^2/4 + Z^4/64)^2) + ...
(11305.*R.^28*S^2*Z^26*(S_v1))/(2199023255552*(1 + Z^2/4 + Z^4/64)^2) + ...
(24225.*R.^30*S^2*Z^28*(S_v1))/(70368744177664*(1 + Z^2/4 + Z^4/64)^2) + ...
(323.*R.^32*S^2*Z^30*(S_v1))/(17592186044416*(1 + Z^2/4 + Z^4/64)^2) + ...
(27455.*R.^34*S^2*Z^32*(S_v1))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + ...
(855.*R.^36*S^2*Z^34*(S_v1))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + ...
(1805.*R.^38*S^2*Z^36*(S_v1))/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^2) + ...
(25.*R.^40*S^2*Z^38*(S_v1))/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^2) + ...
(7.*R.^42*S^2*Z^40*(S_v1))/(147573952589676412928*(1 + Z^2/4 + Z^4/64)^2) + ...
(625.*R.^2*S^2*(S_v1)^2)/(147456*(1 + Z^2/4 + Z^4/64)^4) + ...
(25.*R.^2.*R.*Z^2*S^2*(S_v1)^2)/(768*(1 + Z^2/4 + Z^4/64)^4) + ...
(R.^2.*R.*Z^4*S^2*(S_v1)^2)/(16*(1 + Z^2/4 + Z^4/64)^4) - ...
(1075.*R.^4*S^2*Z^2*(S_v1)^2)/(73728*(1 + Z^2/4 + Z^4/64)^4) + ...
(43.*R.^4.*R.*Z^2*S^2*Z^2*(S_v1)^2)/(768*(1 + Z^2/4 + Z^4/64)^4) + ...

```

$$\begin{aligned}
& (125.*R.^5.*R.*Z^*S^2*Z^3*(S_v1)^2)/(6144*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5.*R.^5.*R.*Z^3*S^2*Z^3*(S_v1)^2)/(64*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (60109.*R.^6*S^2*Z^4*(S_v1)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (407.*R.^6.*R.*Z^2*S^2*Z^4*(S_v1)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (4985.*R.^7.*R.*Z^*S^2*Z^5*(S_v1)^2)/(147456*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^7.*R.*Z^3*S^2*Z^5*(S_v1)^2)/(1536*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (671.*R.^8*S^2*Z^6*(S_v1)^2)/(131072*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (739.*R.^8.*R.*Z^2*S^2*Z^6*(S_v1)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (17111.*R.^9.*R.*Z^*S^2*Z^7*(S_v1)^2)/(589824*(1 + Z^{2/4} + Z^{4/64})^4) - \\
& (3787661.*R.^10*S^2*Z^8*(S_v1)^2)/(301989888*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (31395.*R.^10.*R.*Z^2*S^2*Z^8*(S_v1)^2)/(1048576*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (67529.*R.^11.*R.*Z^*S^2*Z^9*(S_v1)^2)/(1572864*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1627151.*R.^12*S^2*Z^10*(S_v1)^2)/(100663296*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (19657.*R.^12.*R.*Z^2*S^2*Z^10*(S_v1)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (486493.*R.^13.*R.*Z^*S^2*Z^11*(S_v1)^2)/(25165824*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (241027273.*R.^14*S^2*Z^12*(S_v1)^2)/(9663676416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (17773.*R.^14.*R.*Z^2*S^2*Z^12*(S_v1)^2)/(8388608*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3710335.*R.^15.*R.*Z^*S^2*Z^13*(S_v1)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (53842355.*R.^16*S^2*Z^14*(S_v1)^2)/(3221225472*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (2011.*R.^16.*R.*Z^2*S^2*Z^14*(S_v1)^2)/(4194304*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (981421.*R.^17.*R.*Z^*S^2*Z^15*(S_v1)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (19618549477.*R.^18*S^2*Z^16*(S_v1)^2)/(2473901162496*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (206775.*R.^18.*R.*Z^2*S^2*Z^16*(S_v1)^2)/(2147483648*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (607051.*R.^19.*R.*Z^*S^2*Z^17*(S_v1)^2)/(1610612736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (944668661.*R.^20*S^2*Z^18*(S_v1)^2)/(309237645312*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108275.*R.^20.*R.*Z^2*S^2*Z^18*(S_v1)^2)/(6442450944*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4002553.*R.^21.*R.*Z^*S^2*Z^19*(S_v1)^2)/(51539607552*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3348433219.*R.^22*S^2*Z^20*(S_v1)^2)/(3298534883328*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (512435.*R.^22.*R.*Z^2*S^2*Z^20*(S_v1)^2)/(206158430208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5778425.*R.^23.*R.*Z^*S^2*Z^21*(S_v1)^2)/(412316860416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1484626111.*R.^24*S^2*Z^22*(S_v1)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (21031.*R.^24.*R.*Z^2*S^2*Z^22*(S_v1)^2)/(68719476736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (10718225.*R.^25.*R.*Z^*S^2*Z^23*(S_v1)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (33848465467.*R.^26*S^2*Z^24*(S_v1)^2)/(422212465065984*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (272987.*R.^26.*R.*Z^2*S^2*Z^24*(S_v1)^2)/(8796093022208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11158205.*R.^27.*R.*Z^*S^2*Z^25*(S_v1)^2)/(39582418599936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24750045961.*R.^28*S^2*Z^26*(S_v1)^2)/(1266637395197952*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11305.*R.^28.*R.*Z^2*S^2*Z^26*(S_v1)^2)/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (6450277.*R.^29.*R.*Z^*S^2*Z^27*(S_v1)^2)/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (59064594011.*R.^30*S^2*Z^28*(S_v1)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24225.*R.^30.*R.*Z^2*S^2*Z^28*(S_v1)^2)/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (4624109.*R.^31.*R.*Z^*S^2*Z^29*(S_v1)^2)/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (36553306561.*R.^32*S^2*Z^30*(S_v1)^2)/(40532396646334464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (323.*R.^32.*R.*Z^2*S^2*Z^30*(S_v1)^2)/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (679915.*R.^33.*R.*Z^*S^2*Z^31*(S_v1)^2)/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1189947216611.*R.^34*S^2*Z^32*(S_v1)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (27455.*R.^34.*R.*Z^2*S^2*Z^32*(S_v1)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108205.*R.^35.*R.*Z^*S^2*Z^33*(S_v1)^2)/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (105030792781.*R.^36*S^2*Z^34*(S_v1)^2)/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (855.*R.^36.*R.*Z^2*S^2*Z^34*(S_v1)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (990641.*R.^37.*R.*Z^*S^2*Z^35*(S_v1)^2)/(1729382256910270464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (548568674633.*R.^38*S^2*Z^36*(S_v1)^2)/... \\
& (110680464442257309696*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1805.*R.^38.*R.*Z^2*S^2*Z^36*(S_v1)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (294785.*R.^39.*R.*Z^*S^2*Z^37*(S_v1)^2)/(13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (10322387501.*R.^40*S^2*Z^38*(S_v1)^2)/...
\end{aligned}$$

$$\begin{aligned}
& (13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (25.*R.^40.*R.*Z^2*S^2*Z^38*(S_v1)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (32965.*R.^41.*R.*Z^2*S^2*Z^39*(S_v1)^2)/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1462601471251.*R.^42*S^2*Z^40*(S_v1)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (7.*R.^42.*R.*Z^2*S^2*Z^40*(S_v1)^2)/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (15635.*R.^43.*R.*Z^2*S^2*Z^41*(S_v1)^2)/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^44*S^2*Z^42*(S_v1)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (3115.*R.^45.*R.*Z^2*S^2*Z^43*(S_v1)^2)/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (2057042720599.*R.^46*S^2*Z^44*(S_v1)^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) \\
& + ... \\
& (49.*R.^47.*R.*Z^2*S^2*Z^45*(S_v1)^2)/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^48*S^2*Z^46*(S_v1)^2)/... \\
& (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) \\
& (5273670271697.*R.^50*S^2*Z^48*(S_v1)^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (37823055319.*R.^52*S^2*Z^50*(S_v1)^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (31266829573.*R.^54*S^2*Z^52*(S_v1)^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (305764487.*R.^56*S^2*Z^54*(S_v1)^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (155671821505.*R.^58*S^2*Z^56*(S_v1)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (8605263625.*R.^60*S^2*Z^58*(S_v1)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (4487015167.*R.^62*S^2*Z^60*(S_v1)^2)/(3802951800684688204490109616128*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (64197131.*R.^64*S^2*Z^62*(S_v1)^2)/(1267650600228229401496703205376*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (7366421503.*R.^66*S^2*Z^64*(S_v1)^2)/(3894222643901120721397872246915072*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (118374655.*R.^68*S^2*Z^66*(S_v1)^2)/(1947111321950560360698936123457536*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (103217975.*R.^70*S^2*Z^68*(S_v1)^2)/(62307562302417931542365955950641152*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (1169089.*R.^72*S^2*Z^70*(S_v1)^2)/(31153781151208965771182977975320576*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (16453715.*R.^74*S^2*Z^72*(S_v1)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (234365.*R.^76*S^2*Z^74*(S_v1)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (77905.*R.^78*S^2*Z^76*(S_v1)^2)/(765635325572111542792592866721478475776*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (175.*R.^80*S^2*Z^78*(S_v1)^2)/(255211775190703847597530955573826158592*(1 + Z^{2/4} + Z^{4/64})^4) + ... \\
& (49.*R.^82*S^2*Z^80*(S_v1)^2)/(21778071482940061661655974875633165533184*(1 + Z^{2/4} + Z^{4/64})^4); 
\end{aligned}$$

Ns1=Nf1+Nc+Nr1;  
 Phi1=Nf1./[Nc+Nr1];  
 Be1=1./[1+Phi1];  
 Gf1=Nf1./Ns1;  
 Gr1=[Nr1]./Ns1;  
 Nh1=Nc+Nr1;

$S_{v2}=4;$   
 $Nf2=Br^*[(Z^2).^*\exp(-2.^*R.^*Z)+(Z^2)^*\exp(-2^*Z)-2^*Z^2.^*\exp(-Z.R.^*Z)];$   
 $Nr2=(R.^2*S^2)/4 + (25.^*R.^2*S^2*(S_{v2}))/384*(1 + Z^2/4 + Z^4/64)^2) + (R.^2.*R.^*Z^2*S^2*(S_{v2}))/(4*(1 + Z^2/4 + Z^4/64)^2) - ...$   
 $(43.^*R.^4*S^2*Z^2*(S_{v2}))/(384*(1 + Z^2/4 + Z^4/64)^2) + (5.^*R.^5.*R.^*Z^2*S^2*Z^3*(S_{v2}))/(32*(1 + Z^2/4 + Z^4/64)^2) + (407.^*R.^6*S^2*Z^4*(S_{v2}))/(4096*(1 + Z^2/4 + Z^4/64)^2) + ...$   
 $(7.^*R.^7.*R.^*Z^2*S^2*Z^5*(S_{v2}))/(768*(1 + Z^2/4 + Z^4/64)^2) + (539.^*R.^8*S^2*Z^6*(S_{v2}))/(4096*(1 + Z^2/4 + Z^4/64)^2) + ...$   
 $(85225.^*R.^10*S^2*Z^8*(S_{v2}))/(1572864*(1 + Z^2/4 + Z^4/64)^2) + (6487.^*R.^12*S^2*Z^10*(S_{v2}))/(393216*(1 + Z^2/4 + Z^4/64)^2) + ...$   
 $(17773.^*R.^14*S^2*Z^12*(S_{v2}))/(4194304*(1 + Z^2/4 + Z^4/64)^2) + (2011.^*R.^16*S^2*Z^14*(S_{v2}))/(2097152*(1 + Z^2/4 + Z^4/64)^2) + ...$   
 $(206775.^*R.^18*S^2*Z^16*(S_{v2}))/(1073741824*(1 + Z^2/4 + Z^4/64)^2) + (108275.^*R.^20*S^2*Z^18*(S_{v2}))/(3221225472*(1 + Z^2/4 + Z^4/64)^2) + ...$   
 $(512435.^*R.^22*S^2*Z^20*(S_{v2}))/(103079215104*(1 + Z^2/4 + Z^4/64)^2) + (21031.^*R.^24*S^2*Z^22*(S_{v2}))/(34359738368*(1 + Z^2/4 + Z^4/64)^2) + ...$   
 $(272987.^*R.^26*S^2*Z^24*(S_{v2}))/(4398046511104*(1 + Z^2/4 + Z^4/64)^2) + (11305.^*R.^28*S^2*Z^26*(S_{v2}))/(2199023255552*(1 + Z^2/4 + Z^4/64)^2) + ...$   
 $(24225.^*R.^30*S^2*Z^28*(S_{v2}))/(70368744177664*(1 + Z^2/4 + Z^4/64)^2) + (323.^*R.^32*S^2*Z^30*(S_{v2}))/(17592186044416*(1 + Z^2/4 + Z^4/64)^2) + ...$   
 $(27455.^*R.^34*S^2*Z^32*(S_{v2}))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + (855.^*R.^36*S^2*Z^34*(S_{v2}))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + ...$   
 $(1805.^*R.^38*S^2*Z^36*(S_{v2}))/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^2) + (25.^*R.^40*S^2*Z^38*(S_{v2}))/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^2) + ...$   
 $(7.^*R.^42*S^2*Z^40*(S_{v2}))/(147573952589676412928*(1 + Z^2/4 + Z^4/64)^2) + (625.^*R.^2*S^2*(S_{v2})^2)/(147456*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(25.^*R.^2.*R.^*Z^2*S^2*(S_{v2})^2)/(768*(1 + Z^2/4 + Z^4/64)^4) + (R.^2.*R.^*Z^4*S^2*(S_{v2})^2)/(16*(1 + Z^2/4 + Z^4/64)^4) - ...$   
 $(1075.^*R.^4*S^2*Z^2*(S_{v2})^2)/(73728*(1 + Z^2/4 + Z^4/64)^4) - (43.^*R.^4.*R.^*Z^2*S^2*Z^2*(S_{v2})^2)/(768*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(125.^*R.^5.*R.^*Z^2*S^2*Z^3*(S_{v2})^2)/(6144*(1 + Z^2/4 + Z^4/64)^4) + (5.^*R.^5.*R.^*Z^3*S^2*Z^3*(S_{v2})^2)/(64*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(60109.^*R.^6*S^2*Z^4*(S_{v2})^2)/(2359296*(1 + Z^2/4 + Z^4/64)^4) + (407.^*R.^6.*R.^*Z^2*S^2*Z^4*(S_{v2})^2)/(8192*(1 + Z^2/4 + Z^4/64)^4) - ...$   
 $(4985.^*R.^7.*R.^*Z^2*S^2*Z^5*(S_{v2})^2)/(147456*(1 + Z^2/4 + Z^4/64)^4) + (7.^*R.^7.*R.^*Z^3*S^2*Z^5*(S_{v2})^2)/(1536*(1 + Z^2/4 + Z^4/64)^4) - ...$   
 $(671.^*R.^8*S^2*Z^6*(S_{v2})^2)/(131072*(1 + Z^2/4 + Z^4/64)^4) + (739.^*R.^8.*R.^*Z^2*S^2*Z^6*(S_{v2})^2)/(8192*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(17111.^*R.^9.*R.^*Z^2*S^2*Z^7*(S_{v2})^2)/(589824*(1 + Z^2/4 + Z^4/64)^4) - (3787661.^*R.^10*S^2*Z^8*(S_{v2})^2)/(301989888*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(31395.^*R.^10.*R.^*Z^2*S^2*Z^8*(S_{v2})^2)/(1048576*(1 + Z^2/4 + Z^4/64)^4) + (67529.^*R.^11.*R.^*Z^2*S^2*Z^9*(S_{v2})^2)/(1572864*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(1627151.^*R.^12*S^2*Z^10*(S_{v2})^2)/(100663296*(1 + Z^2/4 + Z^4/64)^4) + (19657.^*R.^12.*R.^*Z^2*S^2*Z^10*(S_{v2})^2)/(2359296*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(486493.^*R.^13.*R.^*Z^2*S^2*Z^11*(S_{v2})^2)/(25165824*(1 + Z^2/4 + Z^4/64)^4) + (241027273.^*R.^14*S^2*Z^12*(S_{v2})^2)/(9663676416*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(17773.^*R.^14.*R.^*Z^2*S^2*Z^12*(S_{v2})^2)/(8388608*(1 + Z^2/4 + Z^4/64)^4) + (3710335.^*R.^15.*R.^*Z^2*S^2*Z^13*(S_{v2})^2)/(603979776*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(53842355.^*R.^16*S^2*Z^14*(S_{v2})^2)/(3221225472*(1 + Z^2/4 + Z^4/64)^4) + (2011.^*R.^16.*R.^*Z^2*S^2*Z^14*(S_{v2})^2)/(4194304*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(981421.^*R.^17.*R.^*Z^2*S^2*Z^15*(S_{v2})^2)/(603979776*(1 + Z^2/4 + Z^4/64)^4) + (19618549477.^*R.^18*S^2*Z^16*(S_{v2})^2)/(2473901162496*(1 + Z^2/4 + Z^4/64)^4) + ...$   
 $(206775.^*R.^18.*R.^*Z^2*S^2*Z^16*(S_{v2})^2)/(2147483648*(1 + Z^2/4 + Z^4/64)^4) + (607051.^*R.^19.*R.^*Z^2*S^2*Z^17*(S_{v2})^2)/(1610612736*(1 + Z^2/4 + Z^4/64)^4) + ...$

$$\begin{aligned}
& (944668661.*R.^{20}*S^2*Z^{18}*(S_v2)^2)/(309237645312*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108275.*R.^{20}.*R.^{20}.*Z^2*S^2*Z^{18}*(S_v2)^2)/(6442450944*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4002553.*R.^{21}.*R.^{21}.*Z^2*S^2*Z^{19}*(S_v2)^2)/(51539607552*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3348433219.*R.^{22}.*R.^{22}.*Z^2*S^2*Z^{20}*(S_v2)^2)/(3298534883328*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (512435.*R.^{22}.*R.^{22}.*Z^2*S^2*Z^{20}*(S_v2)^2)/(206158430208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5778425.*R.^{23}.*R.^{23}.*Z^2*S^2*Z^{21}*(S_v2)^2)/(412316860416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1484626111.*R.^{24}.*R.^{24}.*Z^2*S^2*Z^{22}*(S_v2)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (21031.*R.^{24}.*R.^{24}.*Z^2*S^2*Z^{22}*(S_v2)^2)/(68719476736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (10718225.*R.^{25}.*R.^{25}.*Z^2*S^2*Z^{23}*(S_v2)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (33848465467.*R.^{26}.*R.^{26}.*Z^2*S^2*Z^{24}*(S_v2)^2)/(422212465065984*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (272987.*R.^{26}.*R.^{26}.*Z^2*S^2*Z^{24}*(S_v2)^2)/(8796093022208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11158205.*R.^{27}.*R.^{27}.*Z^2*S^2*Z^{25}*(S_v2)^2)/(39582418599936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24750045961.*R.^{28}.*R.^{28}.*Z^2*S^2*Z^{26}*(S_v2)^2)/(1266637395197952*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11305.*R.^{28}.*R.^{28}.*Z^2*S^2*Z^{26}*(S_v2)^2)/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (6450277.*R.^{29}.*R.^{29}.*Z^2*S^2*Z^{27}*(S_v2)^2)/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (59064594011.*R.^{30}.*R.^{30}.*Z^2*S^2*Z^{28}*(S_v2)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24225.*R.^{30}.*R.^{30}.*Z^2*S^2*Z^{28}*(S_v2)^2)/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (4624109.*R.^{31}.*R.^{31}.*Z^2*S^2*Z^{29}*(S_v2)^2)/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (36553306561.*R.^{32}.*R.^{32}.*Z^2*S^2*Z^{30}*(S_v2)^2)/(40532396464334464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (323.*R.^{32}.*R.^{32}.*Z^2*S^2*Z^{30}*(S_v2)^2)/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (679915.*R.^{33}.*R.^{33}.*Z^2*S^2*Z^{31}*(S_v2)^2)/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1189947216611.*R.^{34}.*R.^{34}.*Z^2*S^2*Z^{32}*(S_v2)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (27455.*R.^{34}.*R.^{34}.*Z^2*S^2*Z^{32}*(S_v2)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108205.*R.^{35}.*R.^{35}.*Z^2*S^2*Z^{33}*(S_v2)^2)/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (105030792781.*R.^{36}.*R.^{36}.*Z^2*S^2*Z^{34}*(S_v2)^2)/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (855.*R.^{36}.*R.^{36}.*Z^2*S^2*Z^{34}*(S_v2)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.^{37}.*Z^2*S^2*Z^{35}*(S_v2)^2)/(1729382256910270464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (548568674633.*R.^{38}.*R.^{38}.*Z^2*S^2*Z^{36}*(S_v2)^2)/... \\
& (110680464442257309696*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1805.*R.^{38}.*R.^{38}.*Z^2*S^2*Z^{36}*(S_v2)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.^{39}.*Z^2*S^2*Z^{37}*(S_v2)^2)/(13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (10322387501.*R.^{40}.*R.^{40}.*Z^2*S^2*Z^{38}*(S_v2)^2)/... \\
& (13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (25.*R.^{40}.*R.^{40}.*Z^2*S^2*Z^{38}*(S_v2)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.^{41}.*Z^2*S^2*Z^{39}*(S_v2)^2)/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1462601471251.*R.^{42}.*R.^{42}.*Z^2*S^2*Z^{40}*(S_v2)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^{42}.*R.^{42}.*Z^2*S^2*Z^{40}*(S_v2)^2)/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.^{43}.*Z^2*S^2*Z^{41}*(S_v2)^2)/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^{44}.*R.^{44}.*Z^2*S^2*Z^{42}*(S_v2)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3115.*R.^{45}.*R.^{45}.*Z^2*S^2*Z^{43}*(S_v2)^2)/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}.*R.^{46}.*Z^2*S^2*Z^{44}*(S_v2)^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& + \dots \\
& (49.*R.^{47}.*R.^{47}.*Z^2*S^2*Z^{45}*(S_v2)^2)/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^{48}.*R.^{48}.*Z^2*S^2*Z^{46}*(S_v2)^2)/... \\
& (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5273670271697.*R.^{50}.*R.^{50}.*Z^2*S^2*Z^{48}*(S_v2)^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& Z^{4/64})^4) + \dots \\
& (37823055319.*R.^{52}.*R.^{52}.*Z^2*S^2*Z^{50}*(S_v2)^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& \dots \\
& (31266829573.*R.^{54}.*R.^{54}.*Z^2*S^2*Z^{52}*(S_v2)^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& + \dots \\
& (305764487.*R.^{56}.*R.^{56}.*Z^2*S^2*Z^{54}*(S_v2)^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (155671821505.*R.^{58}.*R.^{58}.*Z^2*S^2*Z^{56}*(S_v2)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots
\end{aligned}$$

$$\begin{aligned}
& (8605263625.*R.^60*S^2*Z^58*(S_v2)^2)/(356526731314189519170947776512*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (4487015167.*R.^62*S^2*Z^60*(S_v2)^2)/(3802951800684688204490109616128*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (64197131.*R.^64*S^2*Z^62*(S_v2)^2)/(1267650600228229401496703205376*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (7366421503.*R.^66*S^2*Z^64*(S_v2)^2)/(3894222643901120721397872246915072*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (118374655.*R.^68*S^2*Z^66*(S_v2)^2)/(1947111321950560360698936123457536*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (103217975.*R.^70*S^2*Z^68*(S_v2)^2)/(62307562302417931542365955950641152*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (1169089.*R.^72*S^2*Z^70*(S_v2)^2)/(31153781151208965771182977975320576*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (16453715.*R.^74*S^2*Z^72*(S_v2)^2)/(23926103924128485712268527085046202368*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (234365.*R.^76*S^2*Z^74*(S_v2)^2)/(23926103924128485712268527085046202368*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (77905.*R.^78*S^2*Z^76*(S_v2)^2)/(765635325572111542792592866721478475776*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (175.*R.^80*S^2*Z^78*(S_v2)^2)/(255211775190703847597530955573826158592*(1 + Z^2/4 + Z^4/64)^4) + \dots \\
& (49.*R.^82*S^2*Z^80*(S_v2)^2)/(21778071482940061661655974875633165533184*(1 + Z^2/4 + Z^4/64)^4);
\end{aligned}$$

```

Ns2=Nf2+Nc+Nr2;
Phi2=Nf2./[Nc+Nr2];
Be2=1./[1+Phi2];
Gf2=Nf2./Ns2;
Gr2=[Nr2]./Ns2;
Nh2=Nc+Nr2;

```

$$\begin{aligned}
S_v3=8; \\
Nf3=Br*[(Z^2).*exp(-2.*R.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-R.*Z)]; \\
Nr3=(R.^2*S^2)/4 + (25.*R.^2*S^2*(S_v3))/(384*(1 + Z^2/4 + Z^4/64)^2) + \\
(R.^2.*R.*Z^2*S^2*(S_v3))/(4*(1 + Z^2/4 + Z^4/64)^2) - \\
(43.*R.^4*S^2*Z^2*(S_v3))/(384*(1 + Z^2/4 + Z^4/64)^2) - \\
+ (5.*R.^5.*R.*Z*S^2*Z^3*(S_v3))/(32*(1 + Z^2/4 + Z^4/64)^2) + \\
(407.*R.^6*S^2*Z^4*(S_v3))/(4096*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(7.*R.^7.*R.*Z*S^2*Z^5*(S_v3))/(768*(1 + Z^2/4 + Z^4/64)^2) + \\
(539.*R.^8*S^2*Z^6*(S_v3))/(4096*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(85225.*R.^10*S^2*Z^8*(S_v3))/(1572864*(1 + Z^2/4 + Z^4/64)^2) + \\
(6487.*R.^12*S^2*Z^10*(S_v3))/(393216*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(17773.*R.^14*S^2*Z^12*(S_v3))/(4194304*(1 + Z^2/4 + Z^4/64)^2) + \\
(2011.*R.^16*S^2*Z^14*(S_v3))/(2097152*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(206775.*R.^18*S^2*Z^16*(S_v3))/(1073741824*(1 + Z^2/4 + Z^4/64)^2) + \\
(108275.*R.^20*S^2*Z^18*(S_v3))/(3221225472*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(512435.*R.^22*S^2*Z^20*(S_v3))/(103079215104*(1 + Z^2/4 + Z^4/64)^2) + \\
(21031.*R.^24*S^2*Z^22*(S_v3))/(34359738368*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(272987.*R.^26*S^2*Z^24*(S_v3))/(4398046511104*(1 + Z^2/4 + Z^4/64)^2) + \\
(11305.*R.^28*S^2*Z^26*(S_v3))/(2199023255552*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(24225.*R.^30*S^2*Z^28*(S_v3))/(70368744177664*(1 + Z^2/4 + Z^4/64)^2) + \\
(323.*R.^32*S^2*Z^30*(S_v3))/(17592186044416*(1 + Z^2/4 + Z^4/64)^2) + \dots \\
(27455.*R.^34*S^2*Z^32*(S_v3))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + \\
(855.*R.^36*S^2*Z^34*(S_v3))/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + \dots
\end{aligned}$$

$$\begin{aligned}
& (1805.*R.^{38}*S^2*Z^36*(S_v3))/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (25.*R.^{40}*S^2*Z^38*(S_v3))/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (7.*R.^{42}*S^2*Z^40*(S_v3))/(147573952589676412928*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (625.*R.^{42}*S^2*(S_v3)^2)/(147456*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (25.*R.^{42}.*R.*Z^2*S^2*(S_v3)^2)/(768*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (R.^{42}.*R.*Z^4*S^2*(S_v3)^2)/(16*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (1075.*R.^{44}*S^2*Z^2*(S_v3)^2)/(73728*(1 + Z^{2/4} + Z^{4/64})^4) - \\
& (43.*R.^{44}.*R.*Z^2*Z^2*S^2*(S_v3)^2)/(768*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (125.*R.^{45}.*R.*Z^3*S^2*Z^3*(S_v3)^2)/(6144*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5.*R.^{45}.*R.*Z^3*S^2*Z^3*(S_v3)^2)/(64*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (60109.*R.^{46}*S^2*Z^4*(S_v3)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (407.*R.^{46}.*R.*Z^2*S^2*Z^4*(S_v3)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (4985.*R.^{47}.*R.*Z^3*S^2*Z^5*(S_v3)^2)/(147456*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^{47}.*R.*Z^3*S^2*Z^5*(S_v3)^2)/(1536*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (671.*R.^{48}*S^2*Z^6*(S_v3)^2)/(131072*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (739.*R.^{48}.*R.*Z^2*S^2*Z^6*(S_v3)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (17111.*R.^{49}.*R.*Z^3*S^2*Z^7*(S_v3)^2)/(589824*(1 + Z^{2/4} + Z^{4/64})^4) - \\
& (3787661.*R.^{49}.*R.*Z^2*Z^8*(S_v3)^2)/(301989888*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (31395.*R.^{50}.*R.*Z^2*Z^2*Z^8*(S_v3)^2)/(1048576*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (67529.*R.^{51}.*R.*Z^3*S^2*Z^9*(S_v3)^2)/(1572864*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1627151.*R.^{52}.*R.*Z^2*Z^10*(S_v3)^2)/(100663296*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (19657.*R.^{52}.*R.*Z^2*Z^2*Z^10*(S_v3)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (486493.*R.^{53}.*R.*Z^3*S^2*Z^11*(S_v3)^2)/(25165824*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (241027273.*R.^{54}.*R.*Z^2*Z^12*(S_v3)^2)/(9663676416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (17773.*R.^{54}.*R.*Z^2*S^2*Z^12*(S_v3)^2)/(8388608*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3710335.*R.^{55}.*R.*Z^3*S^2*Z^13*(S_v3)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (53842355.*R.^{56}.*R.*Z^2*Z^14*(S_v3)^2)/(3221225472*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (2011.*R.^{56}.*R.*Z^2*S^2*Z^14*(S_v3)^2)/(4194304*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (981421.*R.^{57}.*R.*Z^2*S^2*Z^15*(S_v3)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (19618549477.*R.^{57}.*R.*Z^2*Z^16*(S_v3)^2)/(2473901162496*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (206775.*R.^{58}.*R.*Z^2*S^2*Z^16*(S_v3)^2)/(2147483648*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (607051.*R.^{59}.*R.*Z^2*S^2*Z^17*(S_v3)^2)/(1610612736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (944668661.*R.^{59}.*R.*Z^2*Z^18*(S_v3)^2)/(309237645312*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108275.*R.^{60}.*R.*Z^2*S^2*Z^18*(S_v3)^2)/(6442450944*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4002553.*R.^{61}.*R.*Z^2*S^2*Z^19*(S_v3)^2)/(51539607552*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3348433219.*R.^{62}.*R.*Z^2*Z^20*(S_v3)^2)/(3298534883328*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (512435.*R.^{62}.*R.*Z^2*Z^2*Z^20*(S_v3)^2)/(206158430208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5778425.*R.^{63}.*R.*Z^2*Z^2*Z^21*(S_v3)^2)/(412316860416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1484626111.*R.^{64}.*R.*Z^2*Z^22*(S_v3)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (21031.*R.^{64}.*R.*Z^2*S^2*Z^22*(S_v3)^2)/(68719476736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (10718225.*R.^{65}.*R.*Z^2*S^2*Z^23*(S_v3)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (33848465467.*R.^{66}.*R.*Z^2*S^2*Z^24*(S_v3)^2)/(422212465065984*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (272987.*R.^{66}.*R.*Z^2*S^2*Z^24*(S_v3)^2)/(8796093022208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11158205.*R.^{67}.*R.*Z^2*S^2*Z^25*(S_v3)^2)/(39582418599936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24750045961.*R.^{68}.*R.*Z^2*S^2*Z^26*(S_v3)^2)/(1266637395197952*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11305.*R.^{69}.*R.*Z^2*S^2*Z^26*(S_v3)^2)/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (6450277.*R.^{70}.*R.*Z^2*S^2*Z^27*(S_v3)^2)/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (59064594011.*R.^{70}.*R.*Z^2*S^2*Z^28*(S_v3)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24225.*R.^{71}.*R.*Z^2*S^2*Z^28*(S_v3)^2)/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (4624109.*R.^{72}.*R.*Z^2*S^2*Z^29*(S_v3)^2)/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (36553306561.*R.^{73}.*R.*Z^2*S^2*Z^30*(S_v3)^2)/(40532396464334464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (323.*R.^{73}.*R.*Z^2*S^2*Z^30*(S_v3)^2)/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (679915.*R.^{74}.*R.*Z^2*S^2*Z^31*(S_v3)^2)/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1189947216611.*R.^{74}.*R.*Z^2*S^2*Z^32*(S_v3)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (27455.*R.^{75}.*R.*Z^2*S^2*Z^32*(S_v3)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108205.*R.^{76}.*R.*Z^2*S^2*Z^33*(S_v3)^2)/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) + \dots
\end{aligned}$$

$$\begin{aligned}
& (105030792781.*R.^{36}*S^2*Z^{34}*(S_{v3})^2)/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (855.*R.^{36}.*R.*Z^2*S^2*Z^{34}*(S_{v3})^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.*Z^2*S^2*Z^{35}*(S_{v3})^2)/(1729382256910270464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (548568674633.*R.^{38}*S^2*Z^{36}*(S_{v3})^2)/... \\
& (110680464442257309696*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1805.*R.^{38}.*R.*Z^2*S^2*Z^{36}*(S_{v3})^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.*Z^2*S^2*Z^{37}*(S_{v3})^2)/(13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (10322387501.*R.^{40}*S^2*Z^{38}*(S_{v3})^2)/... \\
& (1383505805282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (25.*R.^{40}.*R.*Z^2*S^2*Z^{38}*(S_{v3})^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.*Z^2*S^2*Z^{39}*(S_{v3})^2)/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1462601471251.*R.^{42}*S^2*Z^{40}*(S_{v3})^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^{42}.*R.*Z^2*S^2*Z^{40}*(S_{v3})^2)/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.*Z^2*S^2*Z^{41}*(S_{v3})^2)/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^{44}*S^2*Z^{42}*(S_{v3})^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3115.*R.^{45}.*R.*Z^2*S^2*Z^{43}*(S_{v3})^2)/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}*S^2*Z^{44}*(S_{v3})^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (49.*R.^{47}.*R.*Z^2*S^2*Z^{45}*(S_{v3})^2)/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^{48}*S^2*Z^{46}*(S_{v3})^2)/... \\
& (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5273670271697.*R.^{50}*S^2*Z^{48}*(S_{v3})^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (37823055319.*R.^{52}*S^2*Z^{50}*(S_{v3})^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (31266829573.*R.^{54}*S^2*Z^{52}*(S_{v3})^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (305764487.*R.^{56}*S^2*Z^{54}*(S_{v3})^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (155671821505.*R.^{58}*S^2*Z^{56}*(S_{v3})^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (8605263625.*R.^{60}*S^2*Z^{58}*(S_{v3})^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4487015167.*R.^{62}*S^2*Z^{60}*(S_{v3})^2)/(3802951800684688204490109616128*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (64197131.*R.^{64}*S^2*Z^{62}*(S_{v3})^2)/(1267650600228229401496703205376*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (7366421503.*R.^{66}*S^2*Z^{64}*(S_{v3})^2)/(3894222643901120721397872246915072*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (118374655.*R.^{68}*S^2*Z^{66}*(S_{v3})^2)/(1947111321950560360698936123457536*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (103217975.*R.^{70}*S^2*Z^{68}*(S_{v3})^2)/(62307562302417931542365955950641152*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1169089.*R.^{72}*S^2*Z^{70}*(S_{v3})^2)/(31153781151208965771182977975320576*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (16453715.*R.^{74}*S^2*Z^{72}*(S_{v3})^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (234365.*R.^{76}*S^2*Z^{74}*(S_{v3})^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (77905.*R.^{78}*S^2*Z^{76}*(S_{v3})^2)/(765635325572111542792592866721478475776*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (175.*R.^{80}*S^2*Z^{78}*(S_{v3})^2)/(255211775190703847597530955573826158592*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (49.*R.^{82}*S^2*Z^{80}*(S_{v3})^2)/(21778071482940061661655974875633165533184*(1 + Z^{2/4} + Z^{4/64})^4);
\end{aligned}$$

```

Ns3=Nf3+Nc+Nr3;
Phi3=Nf3./[Nc+Nr3];
Be3=1./[1+Phi3];
Gf3=Nf3./Ns3;
Gr3=[Nr3]./Ns3;
Nh3=Nc+Nr3;

```

$$\begin{aligned}
S_v4 &= 12; \\
Nf4 &= Br^*[(Z^2).^*\exp(-2.^*R.^*Z)+(Z^2)^*\exp(-2^*Z)-2^*Z^2.^*\exp(-Z-R.^*Z)]; \\
Nr4 &= (R.^2*S^2)/4 + (25.^*R.^2*S^2*(S_v4))/(384*(1 + Z^2/4 + Z^4/64)^2) + \\
&\quad (R.^2.*R.^2*S^2*(S_v4))/(4*(1 + Z^2/4 + Z^4/64)^2) - ... \\
&\quad (43.^*R.^4*S^2*Z^2*(S_v4))/(384*(1 + Z^2/4 + Z^4/64)^2) - ... \\
&\quad + (5.^*R.^5.*R.^2*Z^2*(S_v4))/(32*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(407.^*R.^6*S^2*Z^4*(S_v4)) &/(4096*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(7.^*R.^7.*R.^2*Z^2*(S_v4)) &/(768*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(539.^*R.^8*S^2*Z^6*(S_v4)) &/(4096*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(85225.^*R.^10*S^2*Z^8*(S_v4)) &/(1572864*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(6487.^*R.^12*S^2*Z^10*(S_v4)) &/(393216*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(17773.^*R.^14*S^2*Z^12*(S_v4)) &/(4194304*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(2011.^*R.^16*S^2*Z^14*(S_v4)) &/(2097152*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(206775.^*R.^18*S^2*Z^16*(S_v4)) &/(1073741824*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(108275.^*R.^20*S^2*Z^18*(S_v4)) &/(3221225472*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(512435.^*R.^22*S^2*Z^20*(S_v4)) &/(103079215104*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(21031.^*R.^24*S^2*Z^22*(S_v4)) &/(34359738368*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(272987.^*R.^26*S^2*Z^24*(S_v4)) &/(4398046511104*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(11305.^*R.^28*S^2*Z^26*(S_v4)) &/(2199023255552*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(24225.^*R.^30*S^2*Z^28*(S_v4)) &/(70368744177664*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(323.^*R.^32*S^2*Z^30*(S_v4)) &/(17592186044416*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(27455.^*R.^34*S^2*Z^32*(S_v4)) &/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(855.^*R.^36*S^2*Z^34*(S_v4)) &/(36028797018963968*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(1805.^*R.^38*S^2*Z^36*(S_v4)) &/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(25.^*R.^40*S^2*Z^38*(S_v4)) &/(3458764513820540928*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(7.^*R.^42*S^2*Z^40*(S_v4)) &/(147573952589676412928*(1 + Z^2/4 + Z^4/64)^2) + ... \\
(625.^*R.^2*S^2*(S_v4)^2) &/(147456*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(25.^*R.^2.*R.^2*Z^2*(S_v4)^2) &/(768*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(R.^2.*R.^2*Z^4*(S_v4)^2) &/(16*(1 + Z^2/4 + Z^4/64)^4) - ... \\
(1075.^*R.^4*S^2*Z^2*(S_v4)^2) &/(73728*(1 + Z^2/4 + Z^4/64)^4) - ... \\
(43.^*R.^4.*R.^2*Z^2*S^2*Z^2*(S_v4)^2) &/(768*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(125.^*R.^5.*R.^2*Z^3*(S_v4)^2) &/(6144*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(5.^*R.^5.*R.^2*Z^3*S^2*Z^3*(S_v4)^2) &/(64*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(60109.^*R.^6*S^2*Z^4*(S_v4)^2) &/(2359296*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(407.^*R.^6.*R.^2*Z^2*S^2*Z^4*(S_v4)^2) &/(8192*(1 + Z^2/4 + Z^4/64)^4) - ... \\
(4985.^*R.^7.*R.^2*Z^5*(S_v4)^2) &/(147456*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(7.^*R.^7.*R.^2*Z^3*S^2*Z^5*(S_v4)^2) &/(1536*(1 + Z^2/4 + Z^4/64)^4) - ... \\
(671.^*R.^8*S^2*Z^6*(S_v4)^2) &/(131072*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(739.^*R.^8.*R.^2*Z^2*S^2*Z^6*(S_v4)^2) &/(8192*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(17111.^*R.^9.*R.^2*Z^7*(S_v4)^2) &/(589824*(1 + Z^2/4 + Z^4/64)^4) - ... \\
(3787661.^*R.^10*S^2*Z^8*(S_v4)^2) &/(301989888*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(31395.^*R.^10.*R.^2*Z^2*S^2*Z^8*(S_v4)^2) &/(1048576*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(67529.^*R.^11.*R.^2*Z^9*(S_v4)^2) &/(1572864*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(1627151.^*R.^12*S^2*Z^10*(S_v4)^2) &/(100663296*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(19657.^*R.^12.*R.^2*Z^10*(S_v4)^2) &/(2359296*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(486493.^*R.^13.*R.^2*Z^11*(S_v4)^2) &/(25165824*(1 + Z^2/4 + Z^4/64)^4) + ... \\
(241027273.^*R.^14*S^2*Z^12*(S_v4)^2) &/(9663676416*(1 + Z^2/4 + Z^4/64)^4) + ...
\end{aligned}$$

$$\begin{aligned}
& (17773.*R.^{14}.*R.*Z^2*S^2*Z^12*(S_v4)^2)/(8388608*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3710335.*R.^{15}.*R.*Z*S^2*Z^13*(S_v4)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (53842355.*R.^{16}.*S^2*Z^14*(S_v4)^2)/(3221225472*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (2011.*R.^{16}.*R.*Z^2*S^2*Z^14*(S_v4)^2)/(4194304*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (981421.*R.^{17}.*R.*Z*S^2*Z^15*(S_v4)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (19618549477.*R.^{18}.*S^2*Z^16*(S_v4)^2)/(2473901162496*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (206775.*R.^{18}.*R.*Z^2*S^2*Z^16*(S_v4)^2)/(2147483648*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (607051.*R.^{19}.*R.*Z*S^2*Z^17*(S_v4)^2)/(1610612736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (944668661.*R.^{20}.*S^2*Z^18*(S_v4)^2)/(309237645312*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108275.*R.^{20}.*R.*Z^2*S^2*Z^18*(S_v4)^2)/(6442450944*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4002553.*R.^{21}.*R.*Z*S^2*Z^19*(S_v4)^2)/(51539607552*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3348433219.*R.^{22}.*S^2*Z^20*(S_v4)^2)/(3298534883328*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (512435.*R.^{22}.*R.*Z^2*S^2*Z^20*(S_v4)^2)/(206158430208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5778425.*R.^{23}.*R.*Z*S^2*Z^21*(S_v4)^2)/(412316860416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1484626111.*R.^{24}.*S^2*Z^22*(S_v4)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (21031.*R.^{24}.*R.*Z^2*S^2*Z^22*(S_v4)^2)/(68719476736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (10718225.*R.^{25}.*R.*Z*S^2*Z^23*(S_v4)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (33848465467.*R.^{26}.*S^2*Z^24*(S_v4)^2)/(422212465065984*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (272987.*R.^{26}.*R.*Z^2*S^2*Z^24*(S_v4)^2)/(8796093022208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11158205.*R.^{27}.*R.*Z^2*S^2*Z^25*(S_v4)^2)/(39582418599936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24750045961.*R.^{28}.*S^2*Z^26*(S_v4)^2)/(1266637395197952*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11305.*R.^{28}.*R.*Z^2*S^2*Z^26*(S_v4)^2)/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (6450277.*R.^{29}.*R.*Z*S^2*Z^27*(S_v4)^2)/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (59064594011.*R.^{30}.*S^2*Z^28*(S_v4)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24225.*R.^{30}.*R.*Z^2*S^2*Z^28*(S_v4)^2)/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (4624109.*R.^{31}.*R.*Z*S^2*Z^29*(S_v4)^2)/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (36553306561.*R.^{32}.*S^2*Z^30*(S_v4)^2)/(40532396646334464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (323.*R.^{32}.*R.*Z^2*S^2*Z^30*(S_v4)^2)/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (679915.*R.^{33}.*R.*Z*S^2*Z^31*(S_v4)^2)/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1189947216611.*R.^{34}.*S^2*Z^32*(S_v4)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (27455.*R.^{34}.*R.*Z^2*S^2*Z^32*(S_v4)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108205.*R.^{35}.*R.*Z^2*S^2*Z^33*(S_v4)^2)/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (105030792781.*R.^{36}.*S^2*Z^34*(S_v4)^2)/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (855.*R.^{36}.*R.*Z^2*S^2*Z^34*(S_v4)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.*Z^2*S^2*Z^35*(S_v4)^2)/(1729382256910270464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (548568674633.*R.^{38}.*S^2*Z^36*(S_v4)^2)/... \\
& (110680464442257309696*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1805.*R.^{38}.*R.*Z^2*S^2*Z^36*(S_v4)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.*Z^2*S^2*Z^37*(S_v4)^2)/(13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (10322387501.*R.^{40}.*S^2*Z^38*(S_v4)^2)/... \\
& (13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (25.*R.^{40}.*R.*Z^2*S^2*Z^38*(S_v4)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.*Z^2*S^2*Z^39*(S_v4)^2)/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1462601471251.*R.^{42}.*S^2*Z^40*(S_v4)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^{42}.*R.*Z^2*S^2*Z^40*(S_v4)^2)/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.*Z^2*S^2*Z^41*(S_v4)^2)/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^{44}.*S^2*Z^42*(S_v4)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3115.*R.^{45}.*R.*Z^2*S^2*Z^43*(S_v4)^2)/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}.*S^2*Z^44*(S_v4)^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& + \dots \\
& (49.*R.^{47}.*R.*Z^2*S^2*Z^45*(S_v4)^2)/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^{48}.*S^2*Z^46*(S_v4)^2)/...
\end{aligned}$$

$$\begin{aligned}
& (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5273670271697.*R.^50*S^2*Z^48*(S_v4)^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (37823055319.*R.^52*S^2*Z^50*(S_v4)^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (31266829573.*R.^54*S^2*Z^52*(S_v4)^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (305764487.*R.^56*S^2*Z^54*(S_v4)^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (155671821505.*R.^58*S^2*Z^56*(S_v4)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (8605263625.*R.^60*S^2*Z^58*(S_v4)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4487015167.*R.^62*S^2*Z^60*(S_v4)^2)/(3802951800684688204490109616128*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (64197131.*R.^64*S^2*Z^62*(S_v4)^2)/(1267650600228229401496703205376*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (7366421503.*R.^66*S^2*Z^64*(S_v4)^2)/(3894222643901120721397872246915072*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (118374655.*R.^68*S^2*Z^66*(S_v4)^2)/(1947111321950560360698936123457536*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (103217975.*R.^70*S^2*Z^68*(S_v4)^2)/(62307562302417931542365955950641152*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1169089.*R.^72*S^2*Z^70*(S_v4)^2)/(31153781151208965771182977975320576*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (16453715.*R.^74*S^2*Z^72*(S_v4)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (234365.*R.^76*S^2*Z^74*(S_v4)^2)/(23926103924128485712268527085046202368*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (77905.*R.^78*S^2*Z^76*(S_v4)^2)/(765635325572111542792592866721478475776*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (175.*R.^80*S^2*Z^78*(S_v4)^2)/(255211775190703847597530955573826158592*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (49.*R.^82*S^2*Z^80*(S_v4)^2)/(21778071482940061661655974875633165533184*(1 + Z^{2/4} + Z^{4/64})^4);
\end{aligned}$$

Ns4=Nf4+Nc+Nr4;  
 Phi4=Nf4./[Nc+Nr4];  
 Be4=1./[1+Phi4];  
 Gf4=Nf4./Ns4;  
 Gr4=[Nr4]./Ns4;  
 Nh4=Nc+Nr4;

$$\begin{aligned}
& S_v5=16; \\
& Nf5=Br*[(Z^2).*exp(-2.*R.*Z)+(Z^2)*exp(-2*Z)-2*Z^2.*exp(-Z-R.*Z)]; \\
& Nr5=(R.^2*S^2)/4 + (25.*R.^2*S^2*(S_v5))/(384*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (R.^2.*R.^2*S^2*(S_v5))/(4*(1 + Z^{2/4} + Z^{4/64})^2) - \dots \\
& (43.*R.^4*S^2*Z^2*(S_v5))/(384*(1 + Z^{2/4} + Z^{4/64})^2) - \dots \\
& + (5.*R.^5.*R.^2*Z^3*(S_v5))/(32*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (407.*R.^6*S^2*Z^4*(S_v5))/(4096*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (7.*R.^7.*R.^2*Z^5*(S_v5))/(768*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (539.*R.^8*S^2*Z^6*(S_v5))/(4096*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (85225.*R.^10*S^2*Z^8*(S_v5))/(1572864*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (6487.*R.^12*S^2*Z^10*(S_v5))/(393216*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (17773.*R.^14*S^2*Z^12*(S_v5))/(4194304*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (2011.*R.^16*S^2*Z^14*(S_v5))/(2097152*(1 + Z^{2/4} + Z^{4/64})^2) + \dots
\end{aligned}$$

$$\begin{aligned}
& (206775.*R.^{18}*S^2*Z^{16}*(S_v5))/(1073741824*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (108275.*R.^{20}*S^2*Z^{18}*(S_v5))/(3221225472*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (512435.*R.^{22}*S^2*Z^{20}*(S_v5))/(103079215104*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (21031.*R.^{24}*S^2*Z^{22}*(S_v5))/(34359738368*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (272987.*R.^{26}*S^2*Z^{24}*(S_v5))/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (11305.*R.^{28}*S^2*Z^{26}*(S_v5))/(2199023255552*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (24225.*R.^{30}*S^2*Z^{28}*(S_v5))/(70368744177664*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (323.*R.^{32}*S^2*Z^{30}*(S_v5))/(17592186044416*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (27455.*R.^{34}*S^2*Z^{32}*(S_v5))/(36028797018963968*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (855.*R.^{36}*S^2*Z^{34}*(S_v5))/(36028797018963968*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (1805.*R.^{38}*S^2*Z^{36}*(S_v5))/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (25.*R.^{40}*S^2*Z^{38}*(S_v5))/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^2) + \dots \\
& (7.*R.^{42}*S^2*Z^{40}*(S_v5))/(147573952589676412928*(1 + Z^{2/4} + Z^{4/64})^2) + \\
& (625.*R.^{2}*S^2*(S_v5)^2)/(147456*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (25.*R.^{2}.*R.^{2}*Z^2*S^2*(S_v5)^2)/(768*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (R.^{2}.*R.^{2}*Z^4*S^2*(S_v5)^2)/(16*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (1075.*R.^{4}*S^2*Z^2*(S_v5)^2)/(73728*(1 + Z^{2/4} + Z^{4/64})^4) - \\
& (43.*R.^{4}.*R.^{2}*Z^2*S^2*Z^2*(S_v5)^2)/(768*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (125.*R.^{5}.*R.^{2}*Z^3*S^2*Z^3*(S_v5)^2)/(6144*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5.*R.^{5}.*R.^{2}*Z^3*S^2*Z^3*(S_v5)^2)/(64*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (60109.*R.^{6}*S^2*Z^4*(S_v5)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (407.*R.^{6}.*R.^{2}*Z^2*S^2*Z^4*(S_v5)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (4985.*R.^{7}.*R.^{2}*Z^3*S^2*Z^5*(S_v5)^2)/(147456*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^{7}.*R.^{2}*Z^3*S^2*Z^5*(S_v5)^2)/(1536*(1 + Z^{2/4} + Z^{4/64})^4) - \dots \\
& (671.*R.^{8}*S^2*Z^6*(S_v5)^2)/(131072*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (739.*R.^{8}.*R.^{2}*Z^2*S^2*Z^6*(S_v5)^2)/(8192*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (17111.*R.^{9}.*R.^{2}*Z^2*Z^7*(S_v5)^2)/(589824*(1 + Z^{2/4} + Z^{4/64})^4) - \\
& (3787661.*R.^{10}*S^2*Z^8*(S_v5)^2)/(301989888*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (31395.*R.^{10}.*R.^{2}*Z^2*S^2*Z^8*(S_v5)^2)/(1048576*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (67529.*R.^{11}.*R.^{2}*Z^2*Z^9*(S_v5)^2)/(1572864*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1627151.*R.^{12}*S^2*Z^10*(S_v5)^2)/(100663296*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (19657.*R.^{12}.*R.^{2}*Z^2*S^2*Z^10*(S_v5)^2)/(2359296*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (486493.*R.^{13}.*R.^{2}*Z^2*Z^11*(S_v5)^2)/(25165824*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (241027273.*R.^{14}*S^2*Z^12*(S_v5)^2)/(9663676416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (17773.*R.^{14}.*R.^{2}*Z^2*S^2*Z^12*(S_v5)^2)/(8388608*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3710335.*R.^{15}.*R.^{2}*Z^2*S^2*Z^13*(S_v5)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (53842355.*R.^{16}*S^2*Z^14*(S_v5)^2)/(3221225472*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (2011.*R.^{16}.*R.^{2}*Z^2*S^2*Z^14*(S_v5)^2)/(4194304*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (981421.*R.^{17}.*R.^{2}*Z^2*S^2*Z^15*(S_v5)^2)/(603979776*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (19618549477.*R.^{18}*S^2*Z^16*(S_v5)^2)/(2473901162496*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (206775.*R.^{18}.*R.^{2}*Z^2*S^2*Z^16*(S_v5)^2)/(2147483648*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (607051.*R.^{19}.*R.^{2}*Z^2*S^2*Z^17*(S_v5)^2)/(1610612736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (944668661.*R.^{20}*S^2*Z^18*(S_v5)^2)/(309237645312*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108275.*R.^{20}.*R.^{2}*Z^2*S^2*Z^18*(S_v5)^2)/(6442450944*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4002553.*R.^{21}.*R.^{2}*Z^2*S^2*Z^19*(S_v5)^2)/(51539607552*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3348433219.*R.^{22}*S^2*Z^20*(S_v5)^2)/(3298534883328*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (512435.*R.^{22}.*R.^{2}*Z^2*S^2*Z^20*(S_v5)^2)/(206158430208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5778425.*R.^{23}.*R.^{2}*Z^2*S^2*Z^21*(S_v5)^2)/(412316860416*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1484626111.*R.^{24}*S^2*Z^22*(S_v5)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (21031.*R.^{24}.*R.^{2}*Z^2*S^2*Z^22*(S_v5)^2)/(68719476736*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (10718225.*R.^{25}.*R.^{2}*Z^2*S^2*Z^23*(S_v5)^2)/(4947802324992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (33848465467.*R.^{26}*S^2*Z^24*(S_v5)^2)/(422212465065984*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (272987.*R.^{26}.*R.^{2}*Z^2*S^2*Z^24*(S_v5)^2)/(8796093022208*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11158205.*R.^{27}.*R.^{2}*Z^2*S^2*Z^25*(S_v5)^2)/(39582418599936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24750045961.*R.^{28}*S^2*Z^26*(S_v5)^2)/(1266637395197952*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (11305.*R.^{28}.*R.^{2}*Z^2*S^2*Z^26*(S_v5)^2)/(4398046511104*(1 + Z^{2/4} + Z^{4/64})^4) + \dots
\end{aligned}$$

$$\begin{aligned}
& (6450277.*R.^{29}.*R.*Z*S^2*Z^{27}*(S_v5)^2)/(211106232532992*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (59064594011.*R.^{30}*S^2*Z^{28}*(S_v5)^2)/(13510798882111488*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (24225.*R.^{30}.*R.*Z^2*S^2*Z^{28}*(S_v5)^2)/(140737488355328*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (4624109.*R.^{31}.*R.*Z*S^2*Z^{29}*(S_v5)^2)/(1688849860263936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (36553306561.*R.^{32}*S^2*Z^{30}*(S_v5)^2)/(40532396646334464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (323.*R.^{32}.*R.*Z^2*S^2*Z^{30}*(S_v5)^2)/(35184372088832*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (679915.*R.^{33}.*R.*Z*S^2*Z^{31}*(S_v5)^2)/(3377699720527872*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1189947216611.*R.^{34}*S^2*Z^{32}*(S_v5)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (27455.*R.^{34}.*R.*Z^2*S^2*Z^{32}*(S_v5)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (108205.*R.^{35}.*R.*Z*S^2*Z^{33}*(S_v5)^2)/(9007199254740992*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (105030792781.*R.^{36}*S^2*Z^{34}*(S_v5)^2)/(3458764513820540928*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (855.*R.^{36}.*R.*Z^2*S^2*Z^{34}*(S_v5)^2)/(72057594037927936*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (990641.*R.^{37}.*R.*Z*S^2*Z^{35}*(S_v5)^2)/(1729382256910270464*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (548568674633.*R.^{38}*S^2*Z^{36}*(S_v5)^2)/... \\
& (110680464442257309696*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1805.*R.^{38}.*R.*Z^2*S^2*Z^{36}*(S_v5)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (294785.*R.^{39}.*R.*Z*S^2*Z^{37}*(S_v5)^2)/(13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (10322387501.*R.^{40}*S^2*Z^{38}*(S_v5)^2)/... \\
& (13835058055282163712*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (25.*R.^{40}.*R.*Z^2*S^2*Z^{38}*(S_v5)^2)/(6917529027641081856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (32965.*R.^{41}.*R.*Z*S^2*Z^{39}*(S_v5)^2)/(55340232221128654848*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (1462601471251.*R.^{42}*S^2*Z^{40}*(S_v5)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (7.*R.^{42}.*R.*Z^2*S^2*Z^{40}*(S_v5)^2)/(295147905179352825856*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (15635.*R.^{43}.*R.*Z*S^2*Z^{41}*(S_v5)^2)/(1328165573307087716352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (185335180013.*R.^{44}*S^2*Z^{42}*(S_v5)^2)/... \\
& (14167099448608935641088*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (3115.*R.^{45}.*R.*Z*S^2*Z^{43}*(S_v5)^2)/(21250649172913403461632*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (2057042720599.*R.^{46}*S^2*Z^{44}*(S_v5)^2)/(1360041547066457821544448*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (49.*R.^{47}.*R.*Z*S^2*Z^{45}*(S_v5)^2)/(56668397794435742564352*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (24026340573.*R.^{48}*S^2*Z^{46}*(S_v5)^2)/... \\
& (151115727451828646838272*(1 + Z^{2/4} + Z^{4/64})^4) + \\
& (5273670271697.*R.^{50}*S^2*Z^{48}*(S_v5)^2)/(348170636049013202315378688*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (37823055319.*R.^{52}*S^2*Z^{50}*(S_v5)^2)/(29014219670751100192948224*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (31266829573.*R.^{54}*S^2*Z^{52}*(S_v5)^2)/(309485009821345068724781056*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (305764487.*R.^{56}*S^2*Z^{54}*(S_v5)^2)/(43521329506126650289422336*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (155671821505.*R.^{58}*S^2*Z^{56}*(S_v5)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (8605263625.*R.^{60}*S^2*Z^{58}*(S_v5)^2)/(356526731314189519170947776512*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (4487015167.*R.^{62}*S^2*Z^{60}*(S_v5)^2)/(3802951800684688204490109616128*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (64197131.*R.^{64}*S^2*Z^{62}*(S_v5)^2)/(1267650600228229401496703205376*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (7366421503.*R.^{66}*S^2*Z^{64}*(S_v5)^2)/(3894222643901120721397872246915072*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (118374655.*R.^{68}*S^2*Z^{66}*(S_v5)^2)/(1947111321950560360698936123457536*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (103217975.*R.^{70}*S^2*Z^{68}*(S_v5)^2)/(62307562302417931542365955950641152*(1 + Z^{2/4} + Z^{4/64})^4) + \dots \\
& (1169089.*R.^{72}*S^2*Z^{70}*(S_v5)^2)/(31153781151208965771182977975320576*(1 + Z^{2/4} + Z^{4/64})^4) + \dots
\end{aligned}$$

```

(16453715.*R.^74*S^2*Z^72*(S_v5)^2)/(23926103924128485712268527085046202368*(1 + Z^2/4 +
Z^4/64)^4) + ...
(234365.*R.^76*S^2*Z^74*(S_v5)^2)/(23926103924128485712268527085046202368*(1 + Z^2/4 +
Z^4/64)^4) + ...
(77905.*R.^78*S^2*Z^76*(S_v5)^2)/(765635325572111542792592866721478475776*(1 + Z^2/4 +
Z^4/64)^4) + ...
(175.*R.^80*S^2*Z^78*(S_v5)^2)/(255211775190703847597530955573826158592*(1 + Z^2/4 +
Z^4/64)^4) + ...
(49.*R.^82*S^2*Z^80*(S_v5)^2)/(21778071482940061661655974875633165533184*(1 + Z^2/4 +
Z^4/64)^4);

```

```

Ns5=Nf5+Nc+Nr5;
Phi5=Nf5./[Nc+Nr5];
Be5=1./[1+Phi5];
Gf5=Nf5./Ns5;
Gr5=[Nr5]./Ns5;
Nh5=Nc+Nr5;

```

```

plot(R,Ns1,'b',R,Ns2,'g',R,Ns3,'r',R,Ns4,'k',R,Ns5,'m')
% plot(R,Be1,'b',R,Be2,'g',R,Be3,'r',R,Be4,'k',R,Be5,'m')
% plot(R,Phi1,'b',R,Phi2,'g',R,Phi3,'r',R,Phi4,'k',R,Phi5,'m')
% plot(R,Gf1,'b',R,Gf2,'g',R,Gf3,'r',R,Gf4,'k',R,Gf5,'m')
% plot(R,Gr1,'b',R,Gr2,'g',R,Gr3,'r',R,Gr4,'k',R,Gr5,'m')
% plot(R,Nf1,'b',R,Nf2,'g',R,Nf3,'r',R,Nf4,'k',R,Nf5,'m')
% plot(R,Nh1,'b',R,Nh2,'g',R,Nh3,'r',R,Nh4,'k',R,Nh5,'m')

```

PLOTTOOLS ON